SELECTED WATER RESOURCES ABSTRACTS

VOLUME 3, NUMBER 14
JULY 15, 1970

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UNIVERSITY OF KENTUCKY
WATER RESOURCES INSTITUTE
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WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center,
Office of Water Resources Research, U.S. Department of the Interior

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As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.

- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin, jointly sponsored by the FWPCA, Soap and Detergent Association, and the Agricultural Research Service.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

In cooperation with the Federal Water Pollution Control Administration, the following "centers of competence" have been established:

- Thermal pollution at the Department of Sanitary and Water Resources Engineering of Vanderbilt University.
- Textile wastes pollution at the School of Textiles of North Carolina State University.
- Water quality requirements for freshwater and marine organisms at the College of Fisheries of the University of Washington.
- Wastewater treatment and management at the Center for Research in Water Resources of the University of Texas.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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SUBJECT FIELDS AND GROUPS

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01 NATURE OF WATER
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02 WATER CYCLE
Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION
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ABSTRACT SOURCES

SELECTED WATER RESOURCES ABSTRACTS

02. WATER CYCLE

2A. General

COMPARATIVE WATERSHED STUDIES IN SOUTHERN SASKATCHEWAN,
Department of Agriculture, Swift Current (Saskatchewan). Experimental Farm.
W. Nicholaichuk.
American Society of Agricultural Engineers, Transactions, Vol 10, No 4, p 502-504, July-August 1967. 3 fig, 2 tab, 10 ref.

Descriptors: *Demonstration watersheds, *Watersheds (Basins), Runoff, *Precipitation (Atmospheric), *Semiarid climates, Chinook, Drainage, Small watersheds, Snow, Snowmelt, Soil moisture, Rainfall, Measurement, Meteorological data.
Identifiers: *Saskatchewan (Canada).

The comparative study of two semiarid watersheds in Saskatchewan was designed to ascertain differences in quantitative data expressed on a unit basis. Such data included precipitation and runoff volume in acre-inches. The results showed that runoff volumes measured in acre-inches per acre are generally higher for the larger watershed. This might be due in part to the Chinook winds which prevail in the region of the small watershed. Volumes may also differ when compared on a yearly basis even though amount of precipitation is almost equal. The study also indicates that 85% of watershed runoff in southern Saskatchewan is derived from snowmelt. The frequency in which runoff volumes from each watershed are equal was found to be 1.4 years. (Carr-Arizona)
W70-05595

SNOWMELT RUNOFF FROM MEASUREMENTS OF TRITIUM AND OXYGEN-18,
International Atomic Energy Agency, Vienna (Austria); Hydraulic Research Inst., Prague (Czechoslovakia); and Pisa Univ. (Italy). Inst. of Nuclear Geology.
For primary bibliographic entry see Field 02C.
W70-05673

A STOCHASTIC MODEL OF LONGITUDINAL DIFFUSION IN POROUS MEDIA,
Colorado State Univ., Fort Collins.
P. Todorovic.
Water Resources Research, Vol 6, No 1, p 211-222, February 1970. 12 p, 11 fig, 2 tab, 3 ref. NSF Grant GK-11499.

Descriptors: *Statistical models, *Diffusion, *Stochastic processes, *Groundwater movement, *Porous media, Model studies, Mathematical models, Statistical methods, Diffusivity, Hydraulic models, Dispersion, Tracking techniques, Tagging, Tracers.
Identifiers: Longitudinal dispersion.

A set of tagged particles carried along by a fluid flow through a porous media is subject to random dispersion. The total distance from the origin, in the direction of the main flow traveled by a tagged particle, is a stochastic process. To use Lagrangian description of the dispersion, the distribution function of the traveled distance for every time must be determined. This distribution is not Gaussian and depends on two parameters which in turn depend on hydraulic conditions. To apply Eulerian description, the distribution function of time a tagged particle to travel a given distance x is derived. This distribution is not Gaussian either, and depends on the same two parameters. The sum of these two distributions is always one. This identity represents the relationship between Lagrangian and Eulerian descriptions. According to experimental results, the theoretical distributions agree reasonably well with observed distributions. (Knapp-USGS)
W70-05683

URBAN STORM RUNOFF RELATIONS,
Nebraska Univ., Lincoln; Public Health Service, Denver, Colo.; and Maine Univ., Orono.
For primary bibliographic entry see Field 04C.
W70-05684

A METHOD OF DERIVATION OF NONCONSTANT WATERSHED RESPONSE FUNCTIONS,
Agricultural Research Service, Athens, Ga. Southeast Watershed Research Center.
W. M. Snyder, W. C. Mills, and J. C. Stephens.
Water Resources Research, Vol 6, No 1, p 261-274, February 1970. 14 p, 8 fig, 4 tab, 11 ref.

Descriptors: *Hydrograph analysis, *Depth-area-duration analysis, *Rainfall-runoff relationships, Mathematical studies, Mathematical models, Unit hydrographs, Computer programs, Demonstration watersheds, Optimization, Synthetic hydrology, Systems analysis, Runoff forecasting, Streamflow forecasting.
Identifiers: Hydrograph synthesis, Watershed models.

A practical numerical method has been developed for storm hydrograph analysis that allows variation of unit response functions during multiple periods of runoff producing rainfall. Previous methods of analytical derivation of unit responses from multiple period storms require superpositional linearity. This requirement is eliminated by substituting two stages of convolution for the conventional single-stage process of storm hydrograph generation. The first stage convolves a fixed area-characteristic function with a variable state function. The state function is determined by streamflow and differs for each increment of effective rainfall. First stage convolution thus produces a different unit response for each increment. The second stage convolves the variable unit responses and the effective rain increments. Validity of the technique is demonstrated by applying the analytical model to 10 complex storms. The conceptual components of area-characteristic, area-state, and variable response functions resulting from the analyses are seen to be hydrologically rational. (Knapp-USGS)
W70-05685

A GRAPHIC PRESENTATION OF STREAM GAIN OR LOSS AS AN AID IN UNDERSTANDING STREAMFLOW CHARACTERISTICS,
Geological Survey, Huron, S. Dak.
For primary bibliographic entry see Field 02E.
W70-05687

STREAM TEMPERATURE PREDICTION MODEL,
Bonneville Power Administration, Portland, Oreg.
William L. Morse.
Water Resources Research, Vol 6, No 1, p 290-302, February 1970. 13 p, 5 fig, 3 tab, 27 ref.

Descriptors: *Water temperature, *Forecasting, *Mathematical models, Thermal pollution, Reservoirs, Meteorology, Heat transfer, Mass transfer, Convection, Radiation, Conduction, Heat budget, Columbia River.
Identifiers: Water temperature forecasting.

Given certain meteorologic and hydraulic-hydrologic data, a dynamic deterministic one-dimensional model, based on evaluation of the heat exchange across the air-water interface, predicts the water temperatures of streams. The model itself is a quasilinear partial differential equation that represents an abbreviated energy conservation equation. For an extended upper reach (200 miles) of the Columbia River during July 1966, it has predicted water temperatures on the average within 0.3 deg F. More important, this model has been subjected to a statistical validity test which indicates a certain level of acceptance. (Knapp-USGS)
W70-05690

ATMOSPHERIC WATER BALANCE AND HYDROLOGY OF THE UPPER COLORADO RIVER BASIN,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 02B.
W70-05691

LENGTH OF STREAM FOR AN INDEPENDENT EVENTS MODEL,
Northwestern Univ., Evanston, Illinois.
Michael F. Dacey.
Water Resources Research, Vol 6, No 1, p 341-344, February 1970. 4 p, 4 ref. NSF Grant GS-1627.

Descriptors: *Drainage patterns (Geologic), *Tributaries, Drainage density, Statistical methods, Mathematical studies, Geomorphology, Watersheds (Basins), Channel morphology, Streams, Erosion.
Identifiers: *Stream length, Stream order.

An independent events model is formulated for stream length. The stream is composed of links, where the number of links has the geometric distribution and link lengths are independently and identically distributed as the gamma variate with shape parameter a. This model is similar in all essential respects to the topologically random stream structure formulated by Shreve. This paper extends his results and shows that for $a = 2$ the distribution of stream length obeys a probability law defined by the modified Bessel function. It is also shown that when the expected number of links in a stream is large, stream length is approximated by the exponential distribution. (Knapp-USGS)
W70-05696

WEEKLY AND NONTHLY FLOWS IN SYNTHETIC HYDROLOGY,
North Carolina Univ., Chapel Hill; and Florida Univ., Gainesville.
David H. Moreau, and Edwin E. Pyatt.
Water Resources Research, Vol 6, No 1, p 53-61, February 1970. 9 p, 6 fig, 2 tab, 11 ref.

Descriptors: *Synthetic hydrology, *Streamflow forecasting, North Carolina, Markov processes, Statistical models, Simulation analysis, Mathematical models, Systems analysis, Digital computers, Hydrograph analysis, Statistical methods.
Identifiers: Monthly flow moments, Synthetic hydrographs.

A nonstationary model for synthesizing weekly flow patterns, such that means, variances, and covariances of weekly and monthly flows, as estimated from historical records, will be preserved under the assumption of a Markov structure for monthly flows, is developed and applied to the Haw River in North Carolina. Analyses show excellent agreement between statistics of the historical record and those of the simulated record when weekly flows were assumed to follow a log normal distribution. A moving average process is used to reduce sampling errors of parameter estimates from the historical record. (Knapp-USGS)
W70-05698

ROUTE OR CONVOLUTE,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
D. E. Overton.
Water Resources Research, Vol 6, No 1, p 43-52, February 1970. 10 p, 8 fig, 19 ref.

Descriptors: *Unit hydrographs, *Routing, *Streamflow forecasting, *Hydrograph analysis, *Mathematical models, Synthetic hydrology, Simulation analysis, Optimization, Digital computers, Computer programs, Data processing, Model studies, Linear programming, Rainfall-runoff relationships.
Identifiers: Synthetic hydrographs.

Some of the conceptual hydrograph models for routing rainfall excess through a cascade of linear reservoirs have been reexamined. Because of the linearity of these models, convolution of the instantaneous unit hydrograph (IUH) is mathematically identical to synthetic hydrographs obtained by direct routing. Routing, however, has been a more traditional procedure mainly because the mathematics is much simpler and the solution of synthetic hydrographs is more direct. Also, reduction of storm duration in the IUH approach has significant disadvantages. If one chooses a linear cascade model for hydrograph synthesis, direct routing in the traditional sense is more direct, more informative, less tedious, and much less time consuming, and it permits sensitivity analysis of the model parameters as computational trials progress and accomplishes convolution implicitly. (Knapp-USGS)
W70-05702

ON THE THEORY OF EVOLUTION OF RIVER NETS,
Geological Survey, Urbana, Ill.
A. E. Scheidegger.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 109-114, March 1970. 6 p, 1 fig, 2 tab, 10 ref.

Descriptors: *Drainage patterns (Geologic), *Rivers, *Geomorphology, *Statistical models, Model studies, Statistical methods, Streams, Topography, Networks, Watersheds (Basins).
Identifiers: Random graph models, Topology, Stream order.

An investigation is made of the growth of river basins based on the two current models of the structure of such basins: the cyclic model and the random-graph model. Based on the assumption that the networks grow allometrically, the structure of the network that evolves has been calculated based upon the above two models. Nature seems to favor the random-graph model. (Knapp-USGS)
W70-05879

APPLICATIONS OF CROSSING THEORY IN HYDROLOGY,
Technical Univ. of Denmark, Copenhagen. Hydraulic Lab.
For primary bibliographic entry see Field 02E.
W70-05897

RUNOFF FORECASTING BY VARIABLE TRANSFORMATION,
Tokyo Inst. of Tech. (Japan). Dept. of Civil Engineering.
Mikio Hino.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY4, Paper 7203, p 871-878, April 1970. 8 p, 10 fig, 7 ref, append.

Descriptors: *Runoff forecasting, *Rainfall-runoff relationships, Statistical methods, Statistical models, Streamflow forecasting, Runoff, Precipitation (Atmospheric), Frequency analysis.
Identifiers: Spectral analysis.

The linear prediction theory is extended to nonlinear rainfall-runoff systems by a single modification. Variables of rainfall and runoff are transformed by nonlinear functions into a domain where the coherence of rainfall and runoff is considerably increased. The runoff prediction is made in the transformation domain. The inverse transform yields improved runoff. Examples are shown to illustrate that the method is remarkably effective. (Knapp-USGS)
W70-05906

2B. Precipitation

METEOROLOGICAL DROUGHT IN IDAHO AS EXPRESSED BY THE PALMER INDEX,
Weather Bureau, Salt Lake City, Utah. Western Region.
Marvin D. Magnuson.
27 p., typewritten, (1967).

Descriptors: *Droughts, *Arid lands, *Moisture deficit, *Precipitation (Atmospheric), *Idaho, Climatic data, Weather data, Climatology, Rain, Meteorological data.
Identifiers: *Palmer index, *Drought severity, Index values, Meteorological drought.

Drought as a strictly meteorological phenomenon is defined as prolonged, abnormal moisture deficiency. An index has been developed by Palmer which treats drought severity as a function of weighted differences between actual precipitation and precipitation requirements. The method is employed here to provide a drought index for ten climatic regions of the state of Idaho for the years 1931-66. Each drought period is summarized by date of occurrence, duration, maximum severity, and number of months in each index class. This information is combined for each region to give the percentage of total months that were studied which fall within the definition of drought. The summaries reveal that the southwestern valley region of Idaho suffered the greatest percentage of drought months (44%), but that severe and extreme drought were more prevalent in the southwestern highlands. (Carr-Arizona)
W70-05601

METEOROLOGICAL DROUGHT IN MONTANA AS EXPRESSED BY THE PALMER INDEX,
Weather Bureau, Salt Lake City, Utah. Western Region.
Marvin D. Magnuson.
21 p., typewritten, (1967).

Descriptors: *Droughts, *Arid lands, *Moisture deficit, *Precipitation (Atmospheric), *Montana, Climatic data, Weather data, Climatology, Rain, Meteorological data.
Identifiers: *Palmer index, *Drought severity, Index values, Meteorological drought.

Drought as a strictly meteorological phenomenon is defined as prolonged, abnormal moisture deficiency. An index has been developed by Palmer which treats drought severity as a function of weighted differences between actual precipitation and precipitation requirements. The method is employed here to provide a drought index for seven climatic regions of the state of Montana for the years 1931-66. Each drought period is summarized by date of occurrence, duration, maximum severity, and number of months in each index class. This information is combined for each region to give the percentage of total months that were studied which fall within the definition of drought. The summaries reveal that the southeastern region of Montana suffered the greatest percentage of drought months (41%), but that severe and extreme drought were more prevalent in the western region. (Carr-Arizona)
W70-05602

TRITIUM RAINOUT IN THE UNITED STATES DURING 1966, 1967, AND 1968,
Massachusetts Univ., Amherst; and Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 05B.
W70-05670

SPATIAL DISTRIBUTION OF RAINFALL RATES,
Illinois State Water Survey, Urbana.
F. A. Huff.
Water Resources Research, Vol 6, No 1, p 254-260, February 1970. 7 p, 4 fig, 3 tab, 6 ref. Contract INT 14-06-D-6575. Contract DA-36-039-SC-64723.

Descriptors: *Rainfall disposition, *Rainfall intensity, *Distribution patterns, *Rain gages, *Network design, Remote sensing, Radar, Sampling, Meteorology, Isohyetes, Storms, Thunderstorms, Illinois.
Identifiers: Rain gage networks.

A 29-storm sample of 1-minute rainfall rates was obtained with an Illinois network of 50 recording gages in 100 square miles during the warm seasons of 1952 and 1953. These gages were equipped with enlarged orifices and 6-hour charts to provide nearly instantaneous spatial patterns of rainfall intensity on the network. The data were used to determine quantitative estimates of rainfall rate gradients, sampling errors in the measurement of mean areal rates, and spatial correlation patterns. The derived relations are considered first approximations for midwestern warm-season storms. It was concluded that the spatial variability of rainfall rates is frequently so great within and between convective storms that the rain gaging equipment and operational requirements for accurate rate measurements may be prohibitive for most users when sampling areas are 100 sq mi or greater. Consequently it is recommended that the use of radar in combination with recording gages be investigated as a possible solution to the measurement problem. (Knapp-USGS)
W70-05686

ATMOSPHERIC WATER BALANCE AND HYDROLOGY OF THE UPPER COLORADO RIVER BASIN,
Colorado State Univ., Fort Collins.
James L. Rasmussen.
Water Resources Research, Vol 6, No 1, p 62-76, February 1970. 15 p, 15 fig, 7 tab, 21 ref.

Descriptors: Climatology, *Rainfall-runoff relationships, *Colorado River basin, *Water balance, Hydrology, Discharge (Water), Colorado River, Precipitation (Atmospheric), Evaporation, Hydrologic budget, Hydrologic cycle, Rain gages, Precipitation gages, Networks, Topography, Synoptic analysis.
Identifiers: Atmospheric water balance.

The atmospheric water balance over the upper Colorado River is evaluated twice daily for the 7 winter seasons 1957-1963. The atmospheric water balance yields the exchange of water and water vapor at the earth-atmosphere interface through the observation of the spatial and time distributions and fluxes of water vapor in the atmosphere over the basin. The quantity precipitation minus evaporation is determined as a residual of the computation and is accumulated for daily and seasonal values. In addition, a natural period analysis is performed; the natural periods are delineated by homogeneity in the parameter precipitation minus evaporation. The dry periods are shown to exhibit a seasonal trend in evaporation rate as well as decay of evaporation rate with time within periods. Duration is shown to be the dominant factor in storm yield and the occurrence of a few large storms delineates the relatively wet from the relatively dry winters. Finally, the wintertime accumulation of water over the basin and the resulting annual runoff are shown to be highly correlated. (Knapp-USGS)
W70-05691

THE FREQUENCY AND INTENSITY OF WET AND DRY SEASONS AND THEIR INTERRELATIONSHIPS,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
David M. Hershfield.
Water Resources Bulletin, Vol 6, No 1, p 87-93, January-February 1970. 7 p, 3 fig, 4 tab, 6 ref.

Descriptors: *Probability, *Weather forecasting, *Statistical models, Markov processes, Droughts, Weather patterns.
Identifiers: Rainy day sequences, Dry day sequences.

The probabilities of wet- and dry-day sequences of various lengths were determined for several intensities. Dry-and wet-day sequences were studied from actual records of daily precipitation from 35 stations, most of which are east of Denver, for the purpose of describing their statistical distribution. The

geometric destribution is shown to represent the variation in the length of wet-day sequences. The results are identical to those derived from a simple Markov chain model. A relationship is presented which can be used with published data to obtain the one parameter required for the geometric distribution. The average relationship between this one parameter for both the wet and dry sequences is presented. In general, the larger the number of rainy days, the less variability in the annual rainfall totals from year to year and the larger the number of dry (or wet) sequences. Examples are presented which show the probabilities of occurrence associated with recent dry periods in Minnesota and the Washington, D.C., area. (Knapp-USGS)
W70-05704

RAIN GAGE SPACING AND REPORTED RAINFALL,
Universidad Central de Venezuela, Caracas; and Texas A and M Univ., College Station.
For primary bibliographic entry see Field 07A.
W70-05878

PHYSICAL VIEW OF CLOUD SEEDING,
Department of Commerce, Washington, D.C.; and Federal Council for Science and Technology, Washington, D.C.
For primary bibliographic entry see Field 03B.
W70-05893

2C. Snow, Ice, and Frost

SNOWMELT RUNOFF FROM MEASUREMENTS OF TRITIUM AND OXYGEN-18,
International Atomic Energy Agency, Vienna (Austria); Hydraulic Research Inst., Prague (Czechoslovakia); and Pisa Univ. (Italy). Inst. of Nuclear Geology.
T. Dincer, B. R. Payne, T. Florkowski, J. Martinec, and E. Tongiorgi.
Water Resources Research, Vol 6, No 1, p 110-124, February 1970. 15 p, 13 fig, 3 tab, 16 ref.

Descriptors: *Snowmelt, *Infiltration, *Runoff, *Tracers, Tritium, Tracking techniques, Hydrologic budget, Groundwater movement, Recharge, Base flow, Snow management, Snow surveys, Hydrograph analysis, Recession curves, Snowpacks.
Identifiers: Czechoslovakia, Oxygen isotopes, Snow hydrology, Modry Dul basin (Czechoslovakia).

During 1965-1967 the snowmelt runoff in a small mountain basin in northern Czechoslovakia was studied by measuring the tritium and oxygen-18 content of precipitation, snowpack, and runoff, in addition to an improved degree-day method which was used as a standard tool. About two-thirds of the meltwater infiltrated to the soil, and displaced water recharged during the previous years toward the stream channels. The tritium content of the baseflow and the subsurface runoff indicated that the mean residence time of the subsurface water in the basin was approximately 2.5 years with a standard deviation of 1.25 years. The volume of the subsurface storage was estimated to be 2.6 million cu m. The oxygen-18 content of snow samples was in agreement with the tritium results on the relative contribution of the meltwater and subsurface runoff to the total runoff from the basin. (Knapp-USGS)
W70-05673

DEUTERIUM VARIATIONS IN AN ANNUAL SNOWPACK,
Colorado State Univ., Fort Collins; and Geological Survey, Denver, Colo.
Clark Judy, and James R. Meiman.
Water Resources Research, Vol 6, No 1, p 125-129, February 1970. 5 p, 1 fig, 2 tab, 9 ref.

Descriptors: *Snowpacks, *Deuterium, *Snowmelt, *Tracking techniques, Hydrologic cycle, Streamflow, Evaporation, Infiltration, Recharge, Groundwater movement, Precipitation (Atmospheric), Runoff, Data collections, Stable isotopes.
Identifiers: Snowpack metamorphism.

Deuterium samples taken during the 1967-68 snow year in the Rocky Mountains of Colorado indicate that metamorphism and melt of the snowpack greatly reduce the large initial variability in deuterium content of individual snowfalls. New snow values ranged from -229 parts per thousand to -106 parts per thousand D relative to SMOW (Standard Mean Ocean Water). The range in the snowpack profile on May 3, 1968, was -182 to -158. This homogenization would reduce the problems involved in following snowmelt through the hydrologic system. (Knapp-USGS)
W70-05674

THERMAL CONDUCTIVITY OF SNOW BY A TRANSIENT STATE PROBE METHOD,
New Brunswick Univ., Fredericton.
H. Jaafar, and J. J. C. Picot.
Water Resources Research, Vol 6, No 1, p 333-335, February 1970. 3 p, 3 fig, 1 tab, 6 ref.

Descriptors: *Thermal conductivity, *Snow, *Instrumentation, On-site tests, Thermal properties, Ice, Heat transfer, Temperature, Snowpacks.
Identifiers: Thermal conductivity probe.

A transient state thermal conductivity probe (1/4 inch in diameter, 30 inches in length) is described along with the method by which it is used to measure conductivity of snow. Heat is supplied electrically at a constant rate to the probe at a given time after insertion into the sample. After a 4 minute lag, a plot of probe temperature rise against logarithm of time since the start of heating, gives a straight line whose slope is inversely proportional to sample thermal conductivity and proportional to the heating rate. The probe was calibrated against a standardized oil, and the constant was found to be unity. Values for artificially packed snow in the laboratory agreed with published data. However, values found in the field were considerably lower. The device is recommended for field measurements since data can be obtained with minimum disturbance of the snow. (Knapp-USGS)
W70-05695

ON THE EFFECT OF DENSITY INVERSION ON NATURAL CONVECTION IN A MELTED WATER LAYER,
Army Terrestrial Science Center, Hanover, N.H.
Yin-Chao Yen.
Heat Transfer-Philadelphia, Chemical Eng. Progress, Symposium Series, AIChE, 92, Vol. 65, 1969, p245-253, 13 fig, 1 tab, 16 ref.

Descriptors: *Heat transfer, Density, Density currents, Convection, Heat flow, Temperature distribution, Thermodynamic behavior, Thermal conductivity, Ice, Melting, Hydrodynamics.

The effect of maximum density of water near 4C on natural convective heat transfer in the water layer resulting from continuous melting of ice has been studied. In one case, the melting process was initiated by applying heat to the bottom surface of the cylindrical ice sample, and, in the other case, by heating the top. Temperature profiles in the continuously increasing water layer and the amount of water flowing into the melting chamber to compensate for the shrinkage due to phase transition were recorded periodically. For the case of melting from the top with warm plate temperature ranging from 4.06C to 25.10C, it was noted that there existed a constant temperature region of about 3 2C. In the water layer independent of the warm plate temperature, TS, and the heat flux, H, at the interface did not depend on TS, but had a constant value of 0.00168 cal/ (sq.cm.) (sec.). On the other hand, when melting occurred from the bottom, it was found there also existed a constant temperature region, which was dependent on TS. The heat flux was found to be strongly dependent on TS and can be represented by $H = 0.0026$ (T sq.) for TS in the range from 7.70 to 25.50C. A relation between Nusselt number and Rayleigh number was found to exist and could be expressed as $NNu = 0.0804$ (NRa to the 1/3 power). (Novotny-Vanderbilt)
W70-05796

THE PROPAGATION OF DISTURBANCES ON GLACIERS,
Case Western Reserve Univ., Cleveland, Ohio.
Wilbert Lick.
Journal Geophysical Research, Vol 75, No 12, p 2189-2197, April 20, 1970. 9 p, 4 fig, 27 ref.

Descriptors: *Glaciers, *Flow, *Mathematical models, Streamflow, Viscosity, Ice, Convection, Rheology, Regimen, Cryology.
Identifiers: Non-Newtonian flow, Glacier surges.

Simplified models of the time-dependent propagation of disturbances on glaciers are analyzed. A brief discussion of the application to river flows is included. A one-dimensional, time-dependent model including nonlinear convective effects is first presented. A two-dimensional, time-dependent model is then discussed and limiting solutions for short- and long-wavelength disturbances are given. It is shown that short-wavelength disturbances diffuse but do not travel relative to the glacier surface. In the long-wavelength approximation, the results are similar to the results from the one-dimensional model but additional details of the flow field are obtained. Surface height and speed are calculated for specified conditions at the ice-rock interface. (Knapp-USGS)
W70-05888

DYNAMICS OF SNOW AVALANCHE (WITH ESTIMATION FOR FORCE ON A BRIDGE),
Colorado State Univ., Fort Collins. Dept. of Civil Engineering; and Rose Polytechnic Inst., Terre Haute, Ind. Dept. of Mathematics.
H. W. Shen, and A. T. Roper.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 7-26, March 1970. 20 p, 9 fig, 20 ref.

Descriptors: *Avalanches, *Snow, *Mathematical models, Recreation, Highways, Engineering structures, Bridges, Structural engineering, Design, Mathematical studies, Fluid mechanics.
Identifiers: Avalanche forces, Avalanche forecasting.

Critical conditions for the occurrence of snow avalanches are reviewed and summarized. Physical descriptions of slab avalanche, power avalanche and mature powder avalanche are given. A two-dimensional dynamic model based on a fluid mechanics principle describes snow avalanche. The vertical distribution of pressure forces above ground is estimated from this model based on some of the empirical relationships determined by A. Voellmy. Estimations of the forces exerted by a snow avalanche on a proposed bridge are given. (Knapp-USGS)
W70-05896

RECISSION COEFFICIENT IN GLACIER RUNOFF STUDIES,
Swiss Federal Inst. for Snow and Avalanche Research, Davos/Weissfluhjoch; and Hydraulic Research Inst., Prague (Czechoslovakia).
Jaroslav Martinec.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 87-90, March 1970. 4 p, 2 fig, 4 ref.

Descriptors: *Glaciers, *Melting, *Recession curves, *Ablation, Temperature, Correlation analysis, Hydrograph analysis, Mathematical studies, Runoff forecasting.
Identifiers: Glacier runoff.

The use of recession coefficient in the assessment of glacier and snowmelt runoff with regard to temperature is discussed. The variability of this coefficient due to various factors is explained. Relations between the daily glacier runoff volumes and the respective meteorological conditions are affected by the lag factor. If only a part of the melted water leaves the catchment area within the first 24 hours, the glacier runoff continues even with no further melting taking place. (Knapp-USGS)
W70-05902

THE EFFECT OF ALBEDO-REDUCING MATERIALS ON NET RADIATION AT A SNOW SURFACE,
Forest Service (USDA), Ogden, Utah; Forest Service (USDA), Fort Collins, Colo.; and Colorado State Univ., Fort Collins. Dept. of Watershed Resources.
For primary bibliographic entry see Field 03B.
W70-05903

2D. Evaporation and Transpiration

EVAPOTRANSPIRATION AND MICROCLIMATE OF IRRIGATED PASTURES AND ALFALFA UNDER HIGH ALTITUDE CONDITIONS,
Wyoming Univ., Laramie. Dept. of Agricultural Engineering.
R. D. Burman, and T. L. Loudon.
American Society of Agricultural Engineers, Transactions, Vol 11, No 1, p 123-125, 128, January-February 1968. 6 fig, 6 tab, 5 ref.

Descriptors: *Evapotranspiration, *Microclimatology, *Irrigated land, *Irrigation effects, *Pastures, Alfalfa, Wheatgrasses, Arid lands, Wyoming, Altitude, Air circulation, Cloud cover, Crop response, Energy budget, Solar radiation.
Identifiers: *Energy-balance components, *Farson Pilot Farm, Wyoming, *Cool steppes, *Red Desert, Wyoming, Eden Project, Ryegrasses.

Studies were undertaken in 1962-1966 to investigate evapotranspiration and microclimate of high-altitude irrigated pastures. It was found that evapotranspiration from ryegrass-alfalfa pastures was higher than evapotranspiration from wheatgrass-alfalfa pastures, except for a 1-hr midday period when it was lower for the ryegrass-alfalfa mixture. The greatest evapotranspiration difference between crops occurred in the afternoon. Crop evapotranspiration was influenced considerably more by sky conditions than by application of irrigation. Energy-balance components were much higher in bright sunshine than under cloudy skies. Air over the pasture was unstable until late afternoon, with most of the evapotranspiration occuring during the period of instability. (Carr-Arizona)
W70-05590

EFFECTS OF KAOLINITE AS A REFLECTIVE ANTITRANSPIRANT ON LEAF TEMPERATURE, TRANSPIRATION, PHOTOSYNTHESIS, AND WATER-USE EFFICIENCY,
California Univ., Davis.
Antoine Abou-Khaled, Robert M. Hagan, and David C. Davenport.
Water Resources Research, Vol 6, No 1, p 280-289, February 1970. 10 p, 11 fig, 32 ref. OWRR Project B-054-CAL.

Descriptors: *Transpiration control, *Evapotranspiration control, *Kaolinite, Consumptive use, Water conservation, Light intensity, Soil-water-plant relationships.
Identifiers: Antitranspirants.

Transpiration and photosynthesis are influenced by the optical properties of leaves. Application of a uniform white coating of kaolinite to the upper leaf surface produced significant changes in the spectral curves (reflectivity, transmissivity, and absorptivity) of Valencia orange leaves. Photosynthetic light response curves of leaves of orange, lemon, rubber plant (all hypostomatous), and bean (amphibiostomatous) were modified by the reflective material, which at low light intensities decreased photosynthetic rates and increased light saturation levels. The white coating cooled the leaves 3-4 deg C and reduced transpiration 22-28% under conditions of high light intensity, warm air, low relative humidity, and low wind velocity. However the rubber plant under the same conditions showed a smaller reduction in transpiration (less than 10%), indicating effective self-regulation of its water loss. These experiments demonstrated that water-use efficiency of leaves can be improved, particularly under high light intensities. (Knapp-USGS)
W70-05635

EVAPOTRANSPIRATION FROM BARE, HERBACEOUS, AND ASPEN PLOTS: A CHECK ON A FORMER STUDY,
Forest Service (USDA), Ogden, Utah. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 03B.
W70-05693

EVAPORATION IN EAST AFRICA,
East African Agriculture and Forestry Research Organization, Nairobi (Kenya). Physics Div.; and Cotton Research Corp., Kampala (Uganda).
M. Dagg, T. Woodhead, and D. A. Rijks.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 61-67, March 1970. 7 p, 2 fig, 51 ref.

Descriptors: *Evaporation, *Meteorological data, *Environmental effects, *Evapotranspiration, Synoptic analysis, Temperature, Climates, Climatic data, Water demand, Water balance, Hydrologic cycle.
Identifiers: *Penman evaporation estimation, *Africa.

Following a decision to estimate potential evaporation from meteorological observations rather than from evaporation pans, 53 agricultural meteorological stations were established over East Africa with the cooperation of several departments of three governments. Supplementary information from an additional 123 less well equipped stations was incorporated into the preparation of maps of monthly potential open water evaporation, using the Penman estimate. Annual values of potential evaporation range from more than 2,600 mm to less than 1,400 mm with 70% of the area of East Africa having potential evaporation rates of between 1,800 and 2,200 mm per annum. There are marked seasonal variations in evaporation rates, mainly dependent on patterns of cloud cover, but average monthly rates rarely fall below 90 mm even in highland areas. These high rates of water demand have serious implications for the management of water catchments, land planning, crop breeding, tillage techniques, groundwater recharge and rates of primary productivity in rangeland. (Knapp-USGS)
W70-05900

2E. Streamflow and Runoff

METEOROLOGICAL DROUGHT IN IDAHO AS EXPRESSED BY THE PALMER INDEX,
Weather Bureau, Salt Lake City, Utah. Western Region.
For primary bibliographic entry see Field 02B.
W70-05601

METEOROLOGICAL DROUGHT IN MONTANA AS EXPRESSED BY THE PALMER INDEX,
Weather Bureau, Salt Lake City, Utah. Western Region.
For primary bibliographic entry see Field 02B.
W70-05602

GEOLOGICAL SURVEY RESEARCH 1969, CHAPTER A.
Geological Survey, Washington, D.C.

Report available for sale by Superintendent of Documents, US Government Printing Office, Wash, DC 20402 - Price $4.00. Geological Survey Professional Paper 650-A, 1969. 425 p, 11 fig, 79 ref, 3 index.

Descriptors: *Hydrogeology, *Hydrology, *Geology, *Research and development, Bibliographies, Surveys, Reviews, Publications, Water resources.
Identifiers: US Geological Survey Research (1969).

'Geological Survey Research 1969,' the tenth annual review of the economic and scientific work of the U. S. Geological Survey, consists of four chapters (A through D) of Professional Paper 650. Chapter A summarizes significant results, and the remaining chapters consist of collections of short technical papers. Some, but not all, of the results summarized in chapter A are discussed in more detail in the short technical papers of chapters B through D, or in reports listed in 'Publications in Fiscal Year 1969.' (Knapp-USGS)
W70-05639

A FINITE ELEMENT SOLUTION OF THE ONE-DIMENSIONAL DIFFUSION-CONVECTION EQUATION,
California Univ., Davis.
For primary bibliographic entry see Field 08B.
W70-05681

A GRAPHIC PRESENTATION OF STREAM GAIN OR LOSS AS AN AID IN UNDERSTANDING STREAMFLOW CHARACTERISTICS,
Geological Survey, Huron, S. Dak.
Neil C. Koch.
Water Resources Research, Vol 6, No 1, p 239-245, February 1970. 7 p, 4 fig, 7 ref.

Descriptors: *Streamflow, *Surface-groundwater relationships, Base flow, Infiltration, Water loss, Hydrograph analysis, Hydrology, Hydrogeology.
Identifiers: Graphic methods, James River (N Dak).

A graphic presentation of cumulative monthly stream gain or loss on a given stream reach is used as a tool to show whether the stream gain or loss is apparent or real, and to determine the magnitude, time, and cause of the gain or loss. The graphic method could also be used to determine how much of the base flow is groundwater discharge. Interpretations of the cumulative gain or loss graph are described for three reaches on the James River in northeastern South Dakota and southeastern North Dakota. (Knapp-USGS)
W70-05687

ON THE HIERARCHIAL STRUCTURE OF NATURAL DRAINAGE SYSTEMS,
For primary bibliographic entry see Field 04A.
W70-05689

STREAM TEMPERATURE PREDICTION MODEL,
Bonneville Power Administration, Portland, Oreg.
For primary bibliographic entry see Field 02A.
W70-05690

A TECHNIQUE OF GENERATING A SYNTHETIC FLOW RECORD TO ESTIMATE THE VARIABILITY OF DEPENDABLE FLOWS FOR A FIXED RESERVOIR CAPACITY,
North Carolina State Univ., Raleigh; and Virginia Polytechnic Inst., Blacksburg.
N. V. Colston, and J. M. Wiggert.
Water Resources Research, Vol 6, No 1, p 310-315, February 1970. 6 p, 3 fig, 1 tab, 8 ref.

Descriptors: *Synthetic hydrology, *Streamflow forecasting, *Reservoir design, *Cost-benefit analysis, Mathematical models, Statistical models, Rainfall-runoff relationships, Computer programs, Regression analysis.
Identifiers: James River (Va.).

The variability of dependable flows for fixed storage should be incorporated into the economic analysis of a water resource storage project. Flow values representative of the James River were computed by a hydrologic model that uses data randomly generated from monthly precipitation distributions. Dependable flows from fixed storage were found to have large variance. Confidence limits placed on the dependable flows illustrate the wide range of possible dependable flows for a specified reservoir size. Benefit-cost ratios for water resource projects should be expressed in terms of confidence limits. (Knapp-USGS)
W70-05692

THE FLOW INTERVAL METHOD FOR ANALYZING TIMBER HARVESTING EFFECTS ON STREAMFLOW REGIMEN,
Forest Service (USDA), Parsons, W. Va. Northeastern Forest Experiment Station.
For primary bibliographic entry see Field 03B.
W70-05694

LENGTH OF STREAM FOR AN INDEPENDENT EVENTS MODEL,
Northwestern Univ., Evanston, Illinois.
For primary bibliographic entry see Field 02A.
W70-05696

DEPENDENCE OF STREAM LINK LENGTHS AND DRAINAGE AREAS ON STREAM ORDER,
Illinois Univ., Urbana.
A. K. Ghosh, and A. E. Scheidegger.
Water Resources Research, Vol 6, No 1, p 336-340, February 1970. 5 p, 2 tab, 9 ref.

Descriptors: *Drainage patterns (Geologic), *Tributaries, Drainage density, Statistical methods, Mathematical studies, Geomorphology, Watersheds (Basins), Channel morphology, Streams, Erosion.
Identifiers: Bifurcation ratio, Stream order.

It has been suggested in the literature that the lengths of interior links (distances along river course between subsequent junctions) in a given river network are independent random variables drawn from the same population. However, the validity of this basic hypothesis with relation to nature had never been investigated. Thus a test was made to find the exact relationship between the stream lengths and the corresponding stream orders by comparing the theoretical length ratios calculated, assuming all link lengths to be equal, and the natural length ratios for rivers with the same number of first order streams. The results show that the link length always has a tendency to increase geometrically with the Strahler order. This leads to the conclusion that a law of link lengths exists that is similar to the well-known laws of stream orders, stream lengths, and areas. A similar analysis with regard to the areas drained by each link in a river network shows that these areas are constant. (Knapp-USGS)
W70-05697

WEEKLY AND NONTHLY FLOWS IN SYNTHETIC HYDROLOGY,
North Carolina Univ., Chapel Hill; and Florida Univ., Gainesville.
For primary bibliographic entry see Field 02A.
W70-05698

TIME-OF-TRAVEL STUDIES IN THE FALL CREEK BASIN, TOMPKINS COUNTY, NEW YORK,
Geological Survey, Albany, N.Y.
Bernard Dunn.
New York State Water Resources Commission Report of Investigation R1-11, 1970. 21 p, 10 fig, 2 tab.

Descriptors: *Streamflow, *Tracking techniques, *Dye releases, *New York, *Low flow, Stream gages, Discharge measurement, Velocity, Discharge (Water), Flow measurement, Duration curves.
Identifiers: *Time of travel, Dye tracing, Fall Creek (N.Y.).

The time of travel of stream water was determined for a 19.9-mile reach of Fall Creek from McLean to the U. S. Geological Survey gaging station near Ithaca, Tompkins County, New York and for a 5.2-mile reach of Virgil Creek from Dryden to its mouth. The time of travel for Fall Creek during a very low discharge of 9 cfs (cubic feet per second) was more than four times as great as when a medium discharge of 100 cfs prevaled. Channel irregularities and manmade obstructions cause the time of travel through a reach to vary erratically during low flows. For moderate discharges the time of travel was much more uniform throughout the reaches studied. Flow-duration curves were developed and are presented for three sites: (1) the gaging stations on Fall Creek near Ithaca; (2) on Fall Creek at McLean; and (3) on Virgil Creek at Freeville. (Dunn-USGS)
W70-05710

EFFECTS OF URBAN DEVELOPMENT ON DIRECT RUNOFF TO EAST MEADOW BROOK, NASSAU COUNTY, LONG ISLAND, NEW YORK,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 04C.
W70-05712

FLOOD PLAIN INFORMATION OF ANDROSCOGGIN RIVER, AUBURN AND LEWISTON, MAINE.
Army Corps of Engineers, Waltham, Mass. New England Div.
For primary bibliographic entry see Field 04A.
W70-05716

UNIT HYDROGRAPHS FOR SOUTHWESTERN LOUISIANA,
Geological Survey, Baton Rouge, La.
V. B. Sauer.
Louisiana Department of Public Works Technical Report No 2d, 1969. 55 p, 13 fig, 4 tab, 32 ref, append.

Descriptors: *Unit hydrographs, *Rainfall-runoff relationships, *Louisiana, Base flow, Recession curves, Drainage patterns (Geologic), Runoff forecasting, Streamflow forecasting, Storm runoff, Frequency analysis, Gaging stations.
Identifiers: Southwestern Louisiana.

Unit hydrograph and base-flow recession data are provided for 27 stream gaging stations in southwestern Louisiana, an area of about 9,000 square miles. These data can be used at the individual sites to estimate, from rainfall excess, flood hydrographs resulting from large storms. Regionalized data provide methods of estimating unit hydrographs at ungaged sites. A single, dimensionless unit hydrograph is applicable to any site in the study area. The basin parameters, size, mean length, and lag time are the factors necessary to convert the dimensionless unit hydrograph to a specific unit hydrograph for a site. Curves of relation between lag time and mean length provide the best estimate of lag time for ungaged sites. These relations define lag time characteristics for three distinct types of streams in the study area: flat and sluggish streams in the south; moderate to sluggish streams in the north; and more flashy streams, such as Little Sandy Creek, in the north. Base-flow recessions for sites in the study area are related, through a family of curves, to basin size only. Two distinct areas, a south area and a north area, are defined by these curves. (Knapp-USGS)
W70-05717

JAMES RIVER BASIN COMPREHENSIVE WATER RESOURCES PLAN, VOLUME I -- INTRODUCTION.
Virginia Dept. of Conservation and Economic Development, Richmond. Div. of Water Resources.
For primary bibliographic entry see Field 06B.
W70-05724

PROFILES OF A REACH OF THE SAN JOAQUIN RIVER BELOW FRIANT DAM, FRESNO AND MADERA COUNTIES, CALIFORNIA,
Geological Survey, Menlo Park, Calif.
Kenneth W. Lee.
Geological Survey Open-file report, September 1969. 5 p, 1 fig, 4 plate, 2 ref.

Descriptors: *Floods, *California, *Profiles, *Flood forecasting, Flood plains, Stage-discharge relations, Reservoir operation, Mapping, Thalweg, Streamflow.
Identifiers: San Joaquin River (Calif), Friant Dam (Calif).

The water-surface profiles for the release of a maximum of 8,230 cfs from Millerton Lake to the San Joaquin River, California and the water-surface profile for the record release of 12,400 cfs are presented. Bank and thalweg profiles are also shown. The reach of river studied extends 37.3 miles downstream from Friant Dam at the outlet of Millerton Lake. Both flood profiles show inundation of some low-lying areas, confirmed by field observation and aerial photographs. Increased vegetative growth in the channel can cause larger areas to be inundated in the future, particularly in the lower parts of the reach. The depth-reducing effect of localized channel-clearing operations between the two release periods is evident when the two profiles are compared. (Knapp-USGS)
W70-05725

SECONDARY FLOWS IN CURVED OPEN CHANNELS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 08B.
W70-05739

ON THE DEVELOPMENT OF STREAM MEANDERS,
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
Alvin G. Anderson.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A46, p 370-378, 1967. 9 p, 8 fig, 13 ref.

Descriptors: *Channel morphology, *Meanders, *Alluvial channels, *Discharge (Water), Sediment load, Mathematical studies, Statistical models, Bed load.
Identifiers: Meander development.

An analysis was made to relate the mean length of alternate bars in straight alluvial channels and hence the meander length of meandered streams to the flow parameters. Based upon a concept of transverse oscillations, the relative meander length is related to the Froude number of the mean flow and through the Froude number to the discharge. These results are compared with experimental data for the meanders generated in laboratory channels at constant discharge with generally good agreement. The analysis also suggests that there is no unique relationship between meander length and discharge. (Knapp-USGS)
W70-05740

MODEL SIMILARITY AND TRAINING OF RIVER WITH LARGE CHANNEL IRREGULARITIES,
Hydraulic Research Inst., Prague (Czechoslovakia). Dept. of Technical Hydromechanics.
Pavel Novak.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A47, p 379-388, 1967. 10 p, 4 fig, 4 ref.

Descriptors: *Model studies, *Alluvial channels, Hydraulic models, Channel morphology, River training, Simulation analysis.
Identifiers: Aerodynamic model studies, Model scale effects.

The conditions for similarity of open channel flows are outlined in a discussion of the criteria for the construction of hydraulic models of alluvial channels. The relationship of large irregularities in channel shape to the value of the friction coefficient is given and related to prototype behavior. The effects of river training on friction losses in models and streams are calculated. Aerodynamic analogies may be useful in hydraulic model studies. Some aspects of aerodynamic models of streams are discussed. (Knapp-USGS)
W70-05741

SOME RELATIONS OF ENERGY, ROUGHNESS, AND CHANNEL GEOMETRY IN THE LOWER MISSISSIPPI RIVER,
Corps of Engineers, Vicksburg, Miss.
Malcolm G. Anding, and Paul W. Pierce, III.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A48, p 389-397a, 1967. 10 p, 5 fig, 1 tab, 7 ref.

Descriptors: *Channel morphology, *Hydraulics, *Mississippi River, Surveys, Discharge measurement, Mapping, Roughness (Hydraulic), Sediment transport, Alluvial channels, River training, Flood control.
Identifiers: Mississippi channel geometry.

Extensive surveys and investigations are being conducted on the Lower Mississippi River. Improved surveying and drafting procedures now permit more detailed coverage by hydrographic surveys, discharge measurements, bed profiles, and water surface profiles. The objectives of these investigations include isolation and study of the principal hydraulic variables related to transport of water and sediment in large alluvial streams, development of design criteria for river control structures, and analyses of the effects of existing and proposed channel stabilization structures. The basic studies and investigations are described and related to channel types and alignment encountered in the lower river. An energy-roughness concept is given with discussions of the important variables which are believed directly related to the energy slope. Data are presented for two representative reaches of the Mississippi River permitting comparisons of these variables. (Knapp-USGS)
W70-05742

THE ROLE OF SECONDARY CURRENTS IN HYDRAULICS,
Pittsburgh Univ., Pa. School of Engineering.
Chao-Lin Chiu.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A51, p 415-421, 1967. 7 p, 2 fig, 6 ref.

Descriptors: *Open channel flow, *Flow characteristics, *Hydraulics, Turbulent flow, Steady flow, Fluid mechanics, Boundary processes, Channel morphology, Vortices, Water circulation.
Identifiers: Noncircular conduits, Secondary flows.

The role of secondary currents in several areas of hydraulics is described and discussed. The mechanics governing the existence of secondary currents in straight noncircular channels is also presented. The major part of the discussion is based on analytical equations of secondary flow velocities and results of applying a semiempirical method for calculating the sediment concentration under the influence of secondary currents. (Knapp-USGS)
W70-05743

AN APPROXIMATE THEORY OF SECONDARY FLOWS AT THE BEND OF THE RIVER COURSE,
American Inst. of Water Problems and Hydrotechnics, Yerevan (USSR).
A. K. Ananian.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A52, p 422-428, 1967. 7 p, 1 fig, 1 ref.

Descriptors: *Vortices, *Meanders, *Alluvial channels, Open channel flow, Mathematical studies, Boundary processes, Turbulence, Turbulent flow, Channel morphology, Steady flow, Water circulation.
Identifiers: *Secondary flows.

A general differential equation of secondary flows with coaxial currents at any cross section of bends of river courses is deduced from known approximate equations for turbulence. Boundary conditions of integration are formulated and variational methods of solving the task are suggested. The solution of a particular problem relating to the secondary flow in a rectangular river course is considered. (Knapp-USGS)
W70-05744

SECONDARY CURRENTS IN CURVED STRATIFIED RIVERS,
Manchester Univ. (England). Inst. of Science and Technology.
L. N. Chikwendu.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A54, p 438-446, 1967. 9 p, 5 fig, 4 ref.

Descriptors: *Vortices, *Meanders, *Alluvial channels, Open channel flow, Mathematical studies, Boundary processes, Turbulence, Turbulent flow, Channel morphology, Steady flow, Water circulation, Model studies, Hydraulic models, Currents (Water).
Identifiers: *Secondary flows.

Although numerous papers dealing with secondary currents have been published in the past, all of these have been for conditions where the fluid was homogeneous in density. The present paper describes a series of laboratory experiments pertaining to the patterns, magnitudes, and mixing effects of secondary currents in curved density-stratified rivers. The angle made by the stream on the bed, a good measure of the strength of the secondary current, has been correlated by means of empirical equations to fluid flow, and channel geometric properties. (Knapp-USGS)
W70-05745

SECONDARY CURRENTS IN THE NEWCASTLE HARBOUR SILTATION INVESTIGATION,
Department of Public Works, Sydney (Australia). Hydraulic Lab.; and Department of Public Works, Sydney (Australia). Maritime Service Board.
For primary bibliographic entry see Field 02J.
W70-05746

SOME ASPECTS OF FLOW IN MEANDERING CHANNELS,
Illinois Univ., Urbana. Dept. of Civil Engineering.
Ben Chie Yen.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A57, p 465-471, 1967. 7 p, 3 fig, 4 ref.

Descriptors: *Flow, *Alluvial channels, *Vortices, *Meanders, Open channel flow, Model studies, Mathematical studies, Turbulence, Mass transfer, Channel morphology, Currents (Water).
Identifiers: Secondary flows.

The flow in a meandering stream differs from that in a straight channel by the curvilinear characteristics of the former. The fact that the spiral motion is one of the most important characteristics of the flow in a meandering channel and that the effect of the bend extends both upstream and downstream has been conformed by experiments. As the flow pattern changes from section to section, in general there is a lateral mass transfer through any longitudinal section, although its magnitude is usually small compared to the longitudinal mass transfer. The water surface profiles also vary with sections. Moreover, for flow in a meandering channel with bends connected by relatively short tangents, there often exist two or even more spirals. (Knapp-USGS)
W70-05747

THE STABLE PROFILES OF THE CURVED OPEN CHANNEL BEDS,
Public Works Research Inst., Tokyo (Japan).
For primary bibliographic entry see Field 02J.
W70-05749

ON THE THEORY OF EVOLUTION OF RIVER NETS,
Geological Survey, Urbana, Ill.
For primary bibliographic entry see Field 02A.
W70-05879

DRAINAGE DENSITY IN DRIFT-COVERED BASINS,
Washington State Univ., Pullman. Dept. of Engineering.
John F. Orsborn.
ASCE Proceedings, Journal Hydraulics Division, Vol 96, No HY1, Paper 7033, p 183-192, January 1970. 10 p, 6 fig, 4 tab, 10 ref, append.

Descriptors: *Drainage density, *Drainage patterns (Geologic), *Glacial drift, *Floods, Geomorphology, Wisconsin, Frequency analysis, Water balance, Streamflow, Dimensional analysis, Correlation analysis, Base flow, Flood forecasting, Geology, Hydrology.
Identifiers: Big Eau Pleine basin (Wis).

Drainage density, as determined for three drift-covered basins in north-central Wisconsin, has been correlated with mean annual flood flows and base flows. Deviations in the relationship for base flow from two basins are caused by groundwater gains and losses. Correcting for these deviations, drainage density has been related to the streamflow components of surface runoff and groundwater flow, taken as a percentage of total annual runoff. The original analysis of the data, and dimensional analysis, indicate that these streamflow components should be related to drainage density by a power function. This function is not continuous, and therefore a semilogarithmic relationship is developed which satisfies the basic requirement that the sum of surface runoff and baseflow must be total streamflow. The results are indicative of the influences of the soils and geology of the three basins on the streamflow components. (Knapp-USGS)
W70-05884

BED TOPOGRAPHY EFFECT ON FLOW IN A MEANDER,
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
For primary bibliographic entry see Field 8B.
W70-05887

WATER RESOURCES OF NORTHWESTERN ST. LANDRY PARISH AND VICINITY, LOUISIANA,
Geological Survey, Baton Rouge, La.
R. L. Hosman, W. L. Broussard, and A. J. Calandro.
Louisiana Geological Survey and Department of Public Works Water Resources Pamphlet No 23, January 1970. 29 p, 1 plate, 5 tab, 18 ref.

Descriptors: *Water resources, *Surface waters, *Groundwater, *Louisiana, Streamflow, Water quality, Aquifers, Duration curves, Water yield, Hydrographs, Water wells.
Identifiers: St. Landry Parish (La).

Water of good chemical quality is available from both surface water and groundwater sources to residents of the northwestern St. Landry Parish area, Louisiana. Two streams, Bayou Cocodrie and the west protection levee borrow pit channel, appear suitable for development of fairly large supplies. Bayou Cocodrie has a mean discharge of 417 cfs or 269 mgd and a minimum discharge of 50 cfs. Dissolved-solids content normally ranges from 30 to 70 mg/liter, hardness from 30 mg/liter, and pH from 7.0 to 7.5. The west protection levee borrow pit channel has a mean discharge of 529 cfs and a minimum discharge of 6.7 cfs. The Chicot-Atchafalaya acquifer blankets the entire area and is capable of sustaining high well yields. It is 150 to 300 feet thick and contains fresh water throughout the area. The water is characteristically hard and high in iron content and requires treatment for many uses. The Evangeline aquifer, which underlies the Chicot-Atchafalaya aquifer, contains fresh water only in the extreme western part of the area where the water is a sodium bicarbonate type, soft, and generally low in iron. (Knapp-USGS)
W70-05889

APPLICATIONS OF CROSSING THEORY IN HYDROLOGY,
Technical Univ. of Denmark, Copenhagen. Hydraulic Lab.
C. F. Nordin, and D. M. Rosbjerg.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 27-43, March 1970. 17 p, 14 fig, 1 tab, 15 ref.

Descriptors: *Time series analysis, *Hydrologic data, *Statistical methods, Streamflow forecasting, Data processing, Mathematical studies, Frequency analysis.
Identifiers: Crossing theory (Statistics).

Annual hydrologic time series, precipitation or runoff, for example, often exhibit marginal distributions that are approximately Gaussian. When this is the case, many interesting properties of the time series can be predicted by the simple techniques of crossing theory, developed by Rice in connection with analysis of the statistical properties of random noise. The theory would seem to be particularly applicable to estimating the lengths of runs above or below a given level and in providing a definitive measure of persistence in hydrologic time series. (Knapp-USGS)
W70-05897

SIMULATION OF STREAMFLOW IN SCOTLAND,
University of Strathclyde, Glasgow (Scotland). Dept. of Civil Engineering.
George Fleming.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 53-59, March 1970. 7 p, 4 fig, 1 tab, 7 ref.

Descriptors: *Simulation analysis, *Synthetic hydrology, *Computer models, Computer programs, Model studies, Mathematical models, Rainfall-runoff relationships, Systems analysis, Parametric hydrology.
Identifiers: *Stanford Watershed model, Scotland, Clyde River.

The application of mathematical models for simulating the processes of the hydrological cycle is considered and the results of applying a translated version of the Stanford Watershed model to the River Clyde in Scotland are presented. The Stanford Watershed model was found to be a very flexible tool for application to the problem of simulating streamflow from rainfall, evaporation and catchment information. Results obtained from the translated version of the model show good agreement between recorded and simulated flows. The application to the Clyde has been shown to be feasible and further application to other streams in Europe should be possible depending on the availability of data. The potential of the model includes possibilities such as flood estimation, irrigation studies, water supply design, weather modification studies, urban drainage design, and the study of effects of urbanization. (Knapp-USGS)
W70-05899

RUNOFF FORECASTING BY VARIABLE TRANSFORMATION,
Tokyo Inst. of Tech. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 02A.
W70-05906

BOUNDARY SHEAR DISTRIBUTION IN OPEN CHANNEL FLOW,
Indian Inst. of Tech., Kharagpur. Dept. of Civil Engineering.
For primary bibliographic entry see Field 08B.
W70-05907

2F. Groundwater

HYDROCHEMICAL INTERPRETATION OF GROUNDWATER MOVEMENT IN THE RED RIVER VALLEY, MANITOBA,
Department of Energy, Mines and Resources, Ottawa (Ontario).
J. E. Charron.
Inland Waters Branch, Department of Energy, Mines and Resources Scientific Series No 2, Ottawa, Canada, 1969. 31 p, 40 fig, 3 tab, 21 ref.

Descriptors: *Groundwater movement, *Geochemistry, *Hydrogeology, Aquifer characteristics, Geologic control, Aquifers, Water table, Artesian wells, Water chemistry, Water quality.
Identifiers: *Canada, Red River Valley.

A hydrogeological study of the Red River Valley, Manitoba has been in progress for five years. A hydrochemical approach based on the field data is primarily a study of groundwater movement. Groundwater flow is illustrated by means of semilogarithmic diagrams, cross-sections, maps, figures, and tables. Most groundwater is saturated or near saturated in calcium carbonate and not saturated in calcium sulfate. The absolute chloride value is the most important indicator of the degree of sluggishness of a body of groundwater. From recharge to discharge the groundwater tends to become more acidic. In confined aquifers, the direction of groundwater movement can be determined from the hydrochemistry of the groundwater. In a study of this kind there is always the possibility that an understanding of groundwater movement may lead to new mineral discoveries. (Knapp-USGS)
W70-05638

GEOLOGICAL SURVEY RESEARCH 1969, CHAPTER A.
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 02E.
W70-05639

GEOHYDROLOGIC INTERPRETATIONS OF A VOLCANIC ISLAND FROM ENVIRONMENTAL ISOTOPES,
Geological Survey, Washington, D.C.; Atomic Energy Research Inst., Seoul (South Korea); and International Atomic Energy Agency, Vienna (Austria).
For primary bibliographic entry see Field 02K.
W70-05672

THE MECHANISM OF NATURAL GROUNDWATER RECHARGE AND DISCHARGE: 2. LABORATORY COLUMN EXPERIMENTS AND FIELD MEASUREMENTS,
Department of Energy, Mines, and Resources, Calgary (Alberta). Inland Water Branch.
R. Allan Freeze, and James Banner.
Water Resources Research, Vol 6, No 1, p 138-155, February 1970. 18 p, 10 fig, 3 tab, 19 ref.

Descriptors: *Recharge, *Discharge (Water), *Groundwater movement, *Infiltration, Laboratory tests, Model studies, On-site tests, Surveys, Investigations, Observation wells, Grasslands, Mathematical models, Snowmelt, Precipitation (Atmospheric), Saturated flow, Unsaturated flow, Evaporation, Sands, Hydrologic budget, Water balance.
Identifiers: Canada.

A mathematical model was used to simulate one-dimensional, vertical, unsteady, unsaturated flow above a recharging groundwater flow system. Results from this model were correlated with the results from a laboratory column experiment using a tensiometer-transducer system. On the Canadian prairies, cases of recharge-sustaining infiltration to the water table are isolated in time and space. Only spring snowmelt, and on occasion heavy summer rains, are effective. A large percentage of the snowmelt, however, is at the surface prior to the thawing of the frost wedge and therefore does not infiltrate. Effective infiltration is largely in depressions, and some groundwater recharge areas may never receive direct infiltration to the water table. Observation well hydrographs of water-table fluctuations alone are not sufficient to monitor recharge phenomena; measurements of the hydraulic gradient above and below the water table are necessary. It is erroneous to map a sand or gravel plain as an effective recharge area without first investigating the influence of the unsaturated hydrologic properties of the soil. (Knapp-USGS)
W70-05676

HYDRODYNAMIC INSTABILITY OF MISCIBLE FLUIDS IN A VERTICAL POROUS COLUMN,
Guelph Univ. (Ontario).
Y. Bachmat, and D. E. Elrick.
Water Resources Research, Vol 6, No 1, p 156-171, February 1970. 16 p, 9 fig, 3 tab, 8 ref.

Descriptors: *Saline water intrusion, *Porous media, *Groundwater movement, Dispersion, Diffusion, Hydrodynamics, Model studies, Hydraulic models, Solutes, Mixing, Aqueous solutions, Mathematical models, Tracers, Dye releases, Hydraulic conductivity, Mathematical studies.
Identifiers: Hydrodynamic instability.

A series of experiments have been conducted at a constant temperature on the intrusion of salt from a reservoir containing a fixed volume of solution into an underlying long vertical column of porous material, initially saturated with pure water and sealed at the bottom. The variation with time of the salt concentration in the reservoir was measured for different types of porous materials, different initial concentrations, and different mechanical treatments of the solutions. The experimental results, substantiated by the theoretical analyses, indicate that the main contributor to the influx of salt into the porous material is the convective dispersion arising from the onset of horizontal variations of the salt concentration and of the vertical velocity component. Approximate expressions have been

derived for the rate of decrease of the salt concentration in the reservoir, for the influx of salt into the porous material, and for the advances of the salt front within it. (Knapp-USGS)
W70-05677

THEORY OF MULTIPLE LEAKY AQUIFERS,
Universidad Nacional Autonoma de Mexico, Mexico City. Instituto de Fisica.
Ismael Herrera.
Water Resources Research, Vol 6, No 1, p 185-193, February 1970. 9 p, 3 fig, 6 ref.

Descriptors: *Groundwater movement, *Aquifers, *Mathematical studies, Aquifer characteristics, Leakage, Aquitards, Hydraulics, Drawdown, Storage, Permeability, Porosity, Water wells.
Identifiers: Multiple leaky aquifer systems.

The equations governing the motion of multiple leaky aquifer systems are transformed to obtain a simpler system suitable for numerical treatment. An essential feature of the method is the introduction of a lag time that occurs because the influence of any aquifer is not transmitted instantly to its neighbors. This approximation is suitable for treating cases for which the conditions on the aquifers vary slowly. The numerical treatment of the resulting system of equations is of the same order of complexity as that for a single aquifer. (Knapp-USGS)
W70-05679

FIELD AND LABORATORY DETERMINATION OF THE HYDRAULIC DIFFUSIVITY OF A CONFINING BED,
Geological Survey, Washington, D.C.
Roger G. Wolff.
Water Resources Research, Vol 6, No 1, p 194-203, February 1970. 10 p, 12 fig, 1 tab, 14 ref.

Descriptors: *Hydrogeology, *Groundwater movement, *Aquitards, *Diffusivity, On-site tests, Laboratory tests, Hydraulic conductivity, Storage coefficient, Observation wells, Piezometers, Model studies, Mathematical models.
Identifiers: Aquifer testing, Hydraulic diffusivity.

Field and laboratory evaluations of the hydraulic diffusivity of a confining bed are presented. The field approach consisted of measuring the head in the confining layer by placing piezometers equipped with differential pressure transducers at different depths in the confining layer. Pumping from the overlying aquifer resulted in an observed head change at the aquifer confining bed interface which for long periods of time could be approximated by a step drawdown. The best fit of observed data to the set of theoretical type curves for the step drawdown solution yields a hydraulic diffusivity 0.029 sq cm/sec. Hydraulic diffusivity values for the natural effective load, as obtained in the laboratory using consolidation techniques, are in general agreement with this result. Hydraulic conductivity values as determined in the laboratory by consolidation and constant flow methods are generally similar for the same sample. Particle size distribution and the clay mineralogy are also given for each sample. (Knapp-USGS)
W70-05680

A STOCHASTIC MODEL OF LONGITUDINAL DIFFUSION IN POROUS MEDIA,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 02A.
W70-05683

THE TEMPORAL ALLOCATION OF GROUNDWATER - A SIMULATION APPROACH,
Geological Survey, Washington, D.C., and Resources for the Future, Inc., Washington, D.C.
For primary bibliographic entry see Field 06A.
W70-05699

ANNUAL REPORT ON GROUND WATER IN ARIZONA, SPRING 1968 TO SPRING 1969.
Geological Survey, Tucson, Ariz. Water Resources Div.

Arizona Land Department Water Resources Report No 42, December 1969. 46 p, 33 fig, 1 tab.

Descriptors: *Groundwater, *Water resources, *Arizona, Water levels, Water level fluctuations, Water quality, Model studies, Surveys, Reviews, Investigations, Data collections, Hydrologic data.
Identifiers: Arizona water resources.

The status of Arizona's groundwater resources in 1969 is briefly reviewed. Graphs show water levels in selected wells and estimated annual groundwater pumpage in most of the developed areas in the State. Maps show (1) depth to water in selected wells in spring 1969, (2) change in water levels in selected wells from 1964 to 1969, and (3) potential well production by areas. Samples of groundwater for chemical-quality determinations are obtained on an annual basis from about 35 wells and from many other wells on an intermittent schedule. The temperature of the groundwater is obtained coincident with the sampling. The research studies of the Water Resources Division in Arizona are directed toward the hydrology of arid lands. The national programs, which are supported by Federal funds, include basic research in hydrology and applied research in instrumentation and techniques; these programs directly benefit the State program. Projects being supported by the Federal-State cooperative program are: (1) Effects of vegetation manipulation on surface runoff-Sycamore Creek; and (2) Electrical-analog analysis of Avra Valley. (Knapp-USGS)
W70-05718

USE OF GREEN'S FUNCTION IN GROUNDWATER HYDRAULICS,
Princeton Univ., N.J. Dept. of Hydraulics and Hydrology.
Roger J. M. De Wiest.
Tijdschrift Openbare Werken Van Belgie, No 1, p 7-40, 1968-1969. 34 p, 13 fig, 17 ref, 5 append.

Descriptors: *Groundwater movement, *Equations, *Mathematical studies, *Hydraulics, Porous media, Aquifers, Permeability, Flow, Steady flow, Unsteady flow, Uniform flow, Non-uniform flow.
Identifiers: *Greens functions, Gauss theorem, Groundwater hydraulics.

The construction of the Green's function to solve a partial differential equation of mathematical physics for given boundary (and initial) conditions is accomplished in the classical approach with the help of Green's identities, which are briefly reviewed. The underlying basic theorem is the divergence theorem, sometimes known as Gauss' Theorem or as Green's Theorem. The equations are given for two dimensions but they can easily be extended to three dimensions for steady, unsteady, confined, and free-surface groundwater flow to single wells or interfering arrays of wells. The theory of Green's functions has recently been applied to various special problems in groundwater hydraulics. Among the most interesting investigations are domain variations in channel seepage flow, the general solution of the linearized equations of free surface in porous media, and transient two-phase flow through porous media. (Knapp-USGS)
W70-05719

WATER SUPPLY FOR THE NUCLEAR ROCKET DEVELOPMENT STATION AT THE U. S. ATOMIC ENERGY COMMISSION'S NEVADA TEST SITE,
Geological Survey, Denver, Colo.
R. A. Young.
Geological Survey Open-file Report, August 1969. 43 p, 3 fig, 4 tab, 10 ref.

Descriptors: *Water resources, *Groundwater, *Nevada, Arid lands, Aquifers, Recharge, Water wells, Water utilization, Hydrogeology, Hydrologic data, Data collections, Transmissivity.
Identifiers: Aquifer testing, Jackass Flats (Nev).

The Nuclear Rocket Development Station in Jackass Flats, Nevada occupies approximately 123 sq mi in an intermontane valley bordered by highlands on all sides except for a drainage outlet in the southwestern corner. The area has an average annual rainfall of 4 inches. The only important water-producing unit known in the vicinity is a welded-tuff aquifer, the Topopah Spring Member of the Paintbrush Tuff, which receives no significant recharge. Transmissivity, obtained from pumping tests, ranges from 68,000 to 488,000 gpd per ft. Volume of the saturated part of the aquifer is about 3.5 cu mi and the average specific yield probably ranges from 1% to 5%. The volume of groundwater in storage is probably within the range of 37 to 187 billion gallons. This large amount of water should be sufficient to supply the needs of the Nuclear Rocket Development Station for many years. Present average consumption of water is 520,000 gpd, all supplied by one well. This supply well and a standby well have a production capability of 1.6 mgd, adequate for present needs. (Knapp-USGS)
W70-05720

GROUNDWATER DISCHARGE FROM THE EDWARDS AND ASSOCIATED LIMESTONES, SAN ANTONIO AREA, TEXAS, 1968,
Geological Survey, San Antonio, Tex.
Celso Puente.
Edwards Underground Water District Bulletin 20, July 1969. 5 p, 1 tab, 8 ref.

Descriptors: *Springs, *Discharge (Water), *Texas, Water utilization, Aquifers, Limestones, Karst.
Identifiers: Edwards Limestone (Tex).

The 1968 average discharge from the Edwards and associated limestones of Texas is tabulated by county area and by use. Springs include San Marcos Springs in Hays County, Comal Springs in Comal County, San Antonio and San Pedro Springs in Bexar County, and the Leona River Springs in Uvalde County. The recorded discharge for Leona River Springs includes underflow. (Knapp-USGS)
W70-05721

IRON IN GROUND WATERS OF THE MAGOTHY AND RARITAN FORMATIONS IN CAMDEN AND BURLINGTON COUNTIES, NEW JERSEY,
Geological Survey, Trenton, N.J.
For primary bibliographic entry see Field 02K.
W70-05723

DATA FOR SPRINGS IN THE COLORADO DESERT AREA OF CALIFORNIA,
Geological Survey, Menlo Park, Calif.
C. F. Berkstresser, Jr.
Geological Survey Open-file Report, 1969. 13 p, 1 fig, 54 ref, 2 append.

Descriptors: *Springs, *California, Groundwater, Water quality, Discharge (Water), Water yield, Water resources, Water utilization, Data collections, Hydrologic data.
Identifiers: Colorado Desert (California).

Basic data are provided about selected springs in the Colorado Desert of California north of the Mexican border. The report includes description of the springs and the results of analyses of water from the springs. Temperature and pH were measured at the spring site and ammonium was determined qualitatively in the field since January 1963. Flow from springs was measured or estimated, depending on the situation at each site. The location of each site was determined on topographic or other available maps. Chemical and spectrographic analyses were made. Analyses include most of the major, minor, and trace inorganic constituents that occur in natural water. (Knapp-USGS)
W70-05726

METHODS OF GROUNDWATER BALANCE EVALUATION APPLIED IN THE USSR - DEVELOPMENT OF METHODS OF STUDY OF GROUNDWATER BALANCE,
G. V. Bogomolov, B. I. Kudelin, A. V. Lebedev, N. A. Plotnikov, and O. V. Popov.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 135-148, 1968. 14 p, 1 ref.

Descriptors: *Water balance, *Aquifers, *Methodology, *Water resources, Porous media, Artesian wells, Thermodynamic behavior, Aeration, Condensation, Vapor pressure, Salt balance, Heat balance, Dating, Radioisotopes, Model studies.
Identifiers: Soviet Union, Groundwater balance.

The study of the groundwater balance requires an improvement of regional and local methods. Recharge into aquifers, outflow of water from artesian basins, and exchange of water between different aquifers following thermodynamic changes are to be taken into consideration. Other factors to be considered are: (1) Role of condensation water in the aerated zone; (2) role of the vapor phase; (3) salt and heat balance in different environments; (4) tectonic processes; and (5) artificial replenishment of groundwater resources. Natural and artificial isotopes used for dating groundwater and model studies are other methods indicated for evaluation of groundwater. (Carstea-USGS)
W70-05727

THE PRINCIPAL CRITERIA OF THE ANALYSIS OF GEOPHYSICAL FIELDS IN HYDROGEOLOGICAL INVESTIGATIONS WITH SPECIAL REFERENCE TO DESERT REGIONS OF KAZAKHSTAN,
Kazakhstan Geophysical Agency, Alma-Ata (USSR); and All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
For primary bibliographic entry see Field 07B.
W70-05728

THE MAIN PROBLEMS OF STUDYING THE GROUNDWATER REGIME IN THE U.S.S.R.,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
A. A. Konoplyanstev, and V. S. Kovalevsky.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 244-248, 1968. 5 p, 19 ref.

Descriptors: *Groundwater movement, *Water supply, *Hydrodynamics, Methodology, Aeration, Mathematical models, Statistical methods, Irrigated lands, Acid mine water, Networks, Observation wells, Instrumentation, Salt balance, Irrigation, Water supply.
Identifiers: *Soviet Union, Multiple groundwater use.

During the last 20-25 years, the main studies of groundwater in the Soviet Union involved: (1) Development of hydrodynamic fundamentals and methods of analysis, and prediction of the groundwater regime; (2) new methods of studying the elements of unconfined groundwater, moisture dynamics and the water balance in the aeration zone; (3) application of statistical methods and development of different mathematical models. The hydrogeological stations of the Ministry of Geology provide data for: (1) Prediction and evaluation of multiple groundwater use; (2) water supply and irrigation; (3) salt balance in irrigated areas; and (4) acid mine drainage and related problems. There is a special emphasis on the following aspects of groundwater studies: (1) theory of the origin and movement of groundwater; (2) development of regional networks of observation wells and stations; (3) automation of data collecting instruments. (Carstea-USGS)
W70-05729

METHODS OF GROUNDWATER UNSTEADY FLOWS THEORY,
Akademiya Nauk SSSR. Dept. of Applied Hydrodynamics.
P. Y. Kochina-Polubarinova, Y. S. Dzekster, V. G. Pryazhinskoya, Y. V. Sherban, and V. N. Emikh.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 239-243, 1968. 5 p, 4 fig.

Descriptors: *Groundwater movement, *Unsteady flow, Free surfaces, Equations, Methodology, Flow, Mathematical studies.
Identifiers: Boussinesq's equation.

The study of free surface flow described by Boussinesq's equation is an essential part of groundwater unsteady flows theory. These problems are reduced to the determination of free surface flows or to the determination of physical parameters. Analytical solutions of Boussinesq's equation can be successfully obtained only through some special solutions. In most practical problems, numerical integration of the equation may be accomplished by available finite differential solutions. Splitting multidimensional equations into one-dimensional equations provide the most efficient solutions. The direct method of determining the physical parameters is preceded by the integration of Boussinesq's equation if this proves to be possible. If not, then one of the approximation methods is used. (Carstea-USGS)
W70-05730

THE METHODS OF STUDYING THE FREE UNCONFINED GROUNDWATER REGIME IN IRRIGATION REGIONS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
For primary bibliographic entry see Field 04B.
W70-05731

ESTIMATION OF GROUNDWATER BALANCES IN ENGLAND,
Institute of Geological Sciences, London (England).
For primary bibliographic entry see Field 07C.
W70-05732

METHODS OF STUDY OF THE GROUNDWATER BUDGET IN NORTH AMERICA,
R. N. Farvolden.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 108-125, 1968. 18 p, 6 fig, 1 tab, 61 ref.
OWRR Project A-013-ILL.

Descriptors: *Water resources, *Water management (Applied), Decision making, Basins, Safe yield, Water yield, Reservoirs, Aquifers, Brines, Base flow, Hydrogeology.
Identifiers: *Groundwater balance, Groundwater budget.

The concept of the groundwater budget is simple and essential to understanding of the hydrologic cycle. Budget studies can also contribute to the understanding of such features as base flow and the origin of brines in deep aquifers. Generally, early studies led to reasonable estimates of many of the parameters of the budget equation. In contrast, modern research is directed to better and simultaneous measurement of these parameters. The author believes that the factors in the groundwater budget are not important in development of a groundwater reservoir. Further, the concept of 'safe yield' is misleading and if there is such a thing for regional aquifers, it cannot be measured or managed. The paper discusses the following topics: (1) Drainage basin; (2) basin studies; (3) regional studies; (4) budget studies of aquifers; and (5) individual terms of the groundwater budget equation. Good water resources management and the budget are the basis for all decision making. (Carstea-USGS)
W70-05733

THE USE OF AIRPHOTO-INTERPRETATION TECHNIQUES IN WATER RESOURCES SURVEYS,
For primary bibliographic entry see Field 07B.
W70-05734

THE ARCHIVES FOR GROUNDWATER LEVELS T.N.O. IN THE NETHERLANDS,
Rijksinstituut voor Drinkwatervoorziening, The Hague (Netherlands).
For primary bibliographic entry see Field 07C.
W70-05735

PRINCIPLES ON NETWORK DESIGN AND BASIC DATA TO STUDY GROUNDWATER BALANCE,
Research Inst. for Water Resources Development, Budapest (Hungary).
For primary bibliographic entry see Field 07A.
W70-05736

GEOLOGY, HYDROLOGY, AND QUALITY OF WATER IN THE HANFORD-VISALIA AREA, SAN JOAQUIN VALLEY, CALIFORNIA,
Geological Survey, Menlo Park, Calif.
M. G. Croft, and G. V. Gordon.
Geological Survey Open-file report, April 1968. 63 p, 9 fig, 15 plate, 5 tab, 65 ref.

Descriptors: *Water resources, *Hydrogeology, *Groundwater, *California, Aquifers, Irrigation water, Water supply, Groundwater movement, Water quality, Water chemistry, Water wells, Water utilization, Hydrologic budget.
Identifiers: Hanford (Calif), Visalia (Calif), San Joaquin Valley (Calif).

The Hanford-Visalia area is in the southeastern part of the San Joaquin Valley, about 30 miles south of Fresno, Calif. The aquifer system contains groundwater under unconfined, semiconfined, and confined conditions. In general, groundwater is unconfined in the oxidized older alluvium, the younger alluvium, and in the flood-basin deposits. Groundwater is semiconfined in the oxidized and reduced continental deposits and in the reduced and some of the oxidized older alluvium. Confined aquifers occur in the reduced continental deposits and reduced older alluvium below and between impermeable lacustrine clays in the vicinity of Tulare Lake Bed. Irrigation water supply exceeded demand in the wet years and was deficient in dry years. Deficiencies were made good with water pumped from underground storage. Water levels in the Hanford-Visalia area generally declined during this period. Gross groundwater withdrawal is estimated to be 1,240,000 acre-ft in the 1955-56 water year and 2,070,000 acre-ft in the 1959-60 water year. Groundwater in the unconsolidated deposits beneath the alluvial fans, on the east side of the valley, is generally low in dissolved constituents. Groundwater in the oxidized older alluvium and younger alluvium is generally of the calcium bicarbonate type. In the axial trough, groundwater is generally high in mineral constituents and the content is variable. (Knapp-USGS)
W70-05737

WATER RESOURCES OF NORTHWESTERN ST. LANDRY PARISH AND VICINITY, LOUISIANA,
Geological Survey, Baton Rouge, La.
For primary bibliographic entry see Field 02E.
W70-05889

PERTURBATION SOLUTION OF IMBIBITION IN A CRACKED POROUS MEDIUM OF SMALL INCLINATION,
Maharaja Sayajirao Univ. of Baroda (India). Dept. of Mathematics.
A. P. Verma.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 45-51, March 1970. 7 p, 15 ref, append.

Descriptors: *Oil-water interfaces, *Porous media, *Groundwater movement, Fractures (Geology), Permeability, Porosity, Capillary action, Capillary water, Flow.
Identifiers: Imbibition.

An oil-water imbibition phenomenon in a slightly dipping cracked porous medium of finite length is analyzed under special conditions. A solution of the nonlinear differential equation describing linear countercurrent imbibition was derived by a perturbation method, and an expression for the wetting phase saturation was obtained. Some specific results for the dependence of relative permeability on phase saturation, impregnation function, oil-water viscosity ratio, and capillary pressure were assumed from standard literature. (Knapp-USGS)
W70-05898

UNSTEADY SEEPAGE TOWARD SINK BENEATH FREE SURFACE,
Washington Univ., Seattle. Dept. of Civil Engineering.
Bruce W. Hunt.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY4, Paper 7202, p 859-869, April 1970. 11 p, 4 fig, 8 ref, append.

Descriptors: *Groundwater movement, *Unsteady flow, Water table, Porous media, Aquifers, Hydraulics; Mathematical studies, Seepage, Discharge (Water).
Identifiers: Unsteady seepage.

One of the mathematical techniques of linearized wave mechanics is applied to solve the problem of unsteady, axially symmetric seepage toward a sink of variable strength located beneath a free surface. Both finite and infinite aquifer depths are considered, and linearized solutions are given for two distinct types of problems. The first solution corresponds to the problem in which the flow rate to the sink is a specified function of time and the distribution of piezometric head is unknown. The second solution corresponds to the inverse problem in which the piezometric head near the sink is a specified function of time and the flow rate to the sink is unknown. Coordinates of the free surface are determined as part of the solution in each case. The results can also be used to solve the analogous problem which occurs when an aquifer is recharged by a point source. (Knapp-USGS)
W70-05904

2G. Water in Soils

CHARACTERIZATION OF SOIL AERATION DURING SPRINKLER IRRIGATION,
North Dakota State Univ., Stillwater. Dept. of Agricultural Engineering; Michigan State Univ., East Lansing. Dept. of Agricultural Engineering; and Michigan State Univ., East Lansing. Dept. of Soil Science.
E. C. Stegman, A. E. Erickson, and E. H. Kidder.
American Society of Agricultural Engineers, Transactions, Vol 11, No 1, p 16-20, January-February, 1968. 6 fig, 2 tab, 20 ref.

Descriptors: *Sprinkler irrigation, *Aeration, *Infiltration, *Saturation, *Rates of Application, Soil moisture, Soil structure, Irrigation, Irrigation water, Irrigation efficiency, Irrigation practices, Oxygen, Pores.
Identifiers: *Soil aeration, *Pore space saturation, *Soil oxygen deficiency, *Oxygen diffusion rate, *Soil intake rate, Desorption.

Various investigators have concluded that there are beneficial effects when sprinkler irrigation systems apply water at rates well below the normal soil intake rate. Data suggest that decreased soil saturation reduces soil oxygen deficiency. Therefore a study was undertaken to develop a practical technique of evalutating aeration adequacy of soils during irrigation. It was first necessary to know the degree of pore space saturation which could be tolerated by a given soil. This could be realistically evaluated by combining oxygen diffusion rate measurements with a soil-moisture-retention test. Infiltration tests were conducted and it was clearly demonstrated that the rate of application influenced the degree of profile saturation. A feasible application rate existed such that degree of pore space saturation was not exceeded in the transmission zone of each of the soils tested. (Carr-Arizona)
W70-05591

HYDRAULIC DESCRIPTION OF RECESSION OF SHALLOW FLOW OVER A POROUS BED,
Washington State Univ., Pullman. Dept. of Agricultural Engineering.
D. L. Schreiber, and D. L. Bassett.
American Society of Agricultural Engineers, Transactions, Vol 10, No 1, p 54-56, 61, January-February 1967. 2 fig, 6 ref.

Descriptors: *Porosity, *Flow characteristics, *Mathematical models, *Recession curves, *Hydraulics, Flow, Flow measurement, Soil properties, Porous media, Computer models, Laboratory tests, Rational formula, Equations, Design criteria, Water delivery, Runoff, Infiltration, Flumes, Irrigation water, Open channel flow, Surface irrigation.
Identifiers: *Recession of flow, *Recession models, *Shallow flow.

A series of low-gradient, shallow flow studies is summarized. Purpose of the studies was to use a mathematical model to describe recession of flow over a porous bed when discharge onto the bed was stopped. The model consisted of two partial differential equations which were numerically integrated. Model validity was tested by comparing computer solutions with laboratory data for the same flow conditions. It appears that the model and its solution technique adequately describe recession of water over a porous bed. By combining the recession model with a previously-described advance model it should be possible to predict water behavior throughout an irrigation. This has tremendous value for design criteria for field surfaces and water delivery systems. (Carr-Arizona)
W70-05596

SPRINKLER INTENSITY AND SOIL TILTH,
Utah State Univ., Logan. Agricultural and Irrigation Engineering Dept.; and Utah Agricultural Experiment Station, Logan.
Jack Keller.
American Society of Agricultural Engineers, Transactions, Vol 13, No 1, p 118-125, January-February 1970. 10 fig, 4 tab, 16 ref.

Descriptors: *Sprinkler irrigation, *Rates of application, *Soil structure, *Soil mechanics, *Soil texture, Soil strength, Settlement (Structural), Bulk density, Mohr envelope, Time, Drainage, Soil water movement, Soil moisture, Moisture tension, Wetting, Drops (Fluids), Equations, Aggregates, Soil aggregates.
Identifiers: *Tilth, *Soil tilth.

Rate and duration of irrigation application have a definite effect on tilth of medium- and fine-textured soils. When combined with long duration and or poor soil drainage, high application rates can destroy soil tilth. Experimental results showed that the total amount of surface settling of each soil was a function of rate of application and initial bulk density of the sample. It was also found that amount of settling for a given sample and initial density was inversely proportional to minimum soil moisture tension during irrigation. A soil strength theory was proposed in which strength of loosely packed unstable soil to withstand consolidation forces is related to soil moisture tension during irrigation. (Carr-Arizona)
W70-05611

SOME EFFECTS OF SURFACE COVER GEOMETRY ON INFILTRATION RATE,
Auburn Univ., Ala.
J. L. Koon, J. G. Hendrick, and R. E. Hermanson.
Water Resources Research, Vol 6, No 1, p 246-253, February 1970. 8 p, 9 fig, 11 ref. OWRR Project A-005-ALA.

Descriptors: *Infiltration, *Permeability, *Laboratory tests, *Simulated rainfall, Model studies, Puddling, Ponding, Hydraulic models, Vegetation effects, Surface-groundwater relationships, Rainfall disposition, Impact (Rainfall).
Identifiers: Surface permeability, Soil cover effects.

Infiltration into the soil is regulated in part by sealing of the soil surface by raindrop impact. Soil surfaces protected from such impact maintained higher rates of infiltration than exposed soil surfaces. It was hypothesized that the cover particles protected the covered portion of the soil and prevented the reaction of raindrop impact on the soil state. The soil under the cover particles remained in the original state in which infiltration could occur. However, since the cover particles in this study were impervious, infiltration could not occur on the covered area but would occur along the available perimeter of the cover particles. Water would then move in both vertical and lateral directions. The effective lateral distance that the water moved after entry was defined as the effective width. To evaluate the effects of soil surface cover on the infiltration rate of soils exposed to raindrop impact, simulated rainfall was applied at a constant rate to one soil type in small plots with free drainage, and square and rectangular cover particles of varying sizes and percentages were used as surface cover. (Knapp-USGS)
W70-05636

POTABLE WATER AVAILABILITY ON LONG OCEANIC ISLANDS,
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 02L.
W70-05646

DETERMINATION OF SOIL DENSITY AND WATER CONTENT BY FAST NEUTRONS AND GAMMA RAYS,
Du Pont de Nemours (E. I.) and Co., Aiken, S.C.
J. C. Corey, A. R. Boulogne, and J. H. Horton.
Water Resources Research, Vol 6, No 1, p 223-229, February 1970. 7 p, 6 fig, 5 tab, 18 ref. USAEC Contract AT (07-2)-1.

Descriptors: *Nuclear moisture meters, *Gamma rays, *Soil moisture meters, *Instrumentation, Soil water, Bulk density, Moisture content.
Identifiers: Gamma attenuation meters, Neutron attenuation meters.

Sequential measurements of gamma and fast neutron attenuation were used for nondestructive determination of both soil density and water content of soil samples. Soils containing known amounts of water were packed into 22.5-cm diameter cylinders to a depth of 9 cm. Measurements were made of attenuation of fast neutrons and attenuation of gamma rays in a collimated beam. The attenuation was used to calculate the soil density and water content of these samples. The mean difference between the calculated and known water contents was 0.006 g/cc with a standard deviation of 0.010 g/cc; the mean difference for soil density was 0.010 g/cc with a standard deviation of 0.017 g/cc. Calculations based only on counting statistics show that an attenuation method using a combination of gamma and fast neutrons is better than a method using 2 gamma energies. (Knapp-USGS)
W70-05682

SOIL TEMPERATURE PROFILES DURING INFILTRATION AND REDISTRIBUTION OF COOL AND WARM IRRIGATION WATER,
California Univ., Davis.
P. J. Wierenga, R. M. Hagan, and D. R. Nielsen.

Water Resources Research, Vol 6, No 1, p 230-238, February 1970. 9 p, 6 fig, 2 tab, 14 ref.

Descriptors: *Soil temperature, *Infiltration, *Irrigation water, Mass transfer, Percolation, Heat transfer, Conduction, Convection, Evaporation, Soil-water-plant relationships.
Identifiers: Warm water irrigation.

Soil temperatures were measured in field profiles irrigated with cool and warm water and also measured in nonirrigated soil. Differences in soil temperature between plots after irrigation with cool (4.1 deg C) and warm (21.6 deg C) water, persisted longer at the lower soil depths. The time required after an irrigation for these differences to decline to less than 1 deg C was 14 hours at the 1-cm depth, 36 hours at the 10-cm depth, and 42 hours at the 20-cm depth. A numerical procedure developed for predicting changes in soil temperature through the soil profile after irrigation with cool and warm water gave good agreement between observed and calculated values in the subsoil but not in the surface soil. During infiltration heat transfer occurred mainly by mass movement, whereas after 10 hours soil heat transfer below 10 cm occurred mainly by conduction. (Knapp-USGS)
W70-05688

2H. Lakes

EUTROPHICATION TRENDS IN A CHAIN OF ARTIFICIAL LAKES IN MADRAS (INDIA),
Hydrological Research Station, Kilpauk (India).
A. Sreenivasan.
Environmental Health, Vol 11, p 392-401, 1969. 5 tab, 22 ref.

Descriptors: *Reservoirs, *Eutrophication, Nitrogen, Oxygen, Oxidation, Carbon dioxide, Alkalinity, Algae.
Identifiers: India, Methyl orange, Algal blooms.

Eutrophication of four consecutive artificial lakes--Ooty, Sandynulla, Pykara and Glenmorgan Forebay, India,--is discussed. Morphometric data, general conditions of the lakes for the years 1965-1967, the hydrological conditions of Glenmorgan Reservoir, and the quality of influent water into Ooty Lake and its outflow, are furnished. Due to damage of a waste disposal pipe, sewage has discharged into Ooty making it hyper-eutrophic. During 1962-1963, oxygen depletion below 2.0 was noted. During 1965-1966 steep gradients in free carbon dioxide and methyl orange alkalinity were noted and the organic nitrogen content reached 7.6-18.0 milligrams/liter. Ooty Lake plankton is dense year round with Microcystis aeruginosa occurring as a permanent bloom. Carbon dioxide accumulates in the bottom of Sandynulla Reservoir, but not as severely as in Ooty. Methyl orange alkalinity gradient was noted from surface to bottom during certain periods, more or less reflecting the influence of Ooty Lake. Oxygen depletion in the bottom was noted and organic nitrogen content was 2.1-15.0 ppm. Pykara Lake showed no change. Glenmorgan Forebay shows that it is not influenced by the waters from the other lakes. The removal of bottom sediments from Ooty is suggested to alleviate the problem. (Haskins-Wisconsin)
W70-05550

FACTORS INVOLVED IN DISPOSAL OF SEWAGE EFFLUENTS TO LAKES,
Massachusetts Inst. of Tech., Cambridge. Dept. of Sanitary Chemistry.
For primary bibliographic entry see Field 05C.
W70-05565

FACTORS IN LAKE TYPOLOGY IN BRITISH COLUMBIA, CANADA,
P. A. Larkin, and T. G. Northcote.
Verhandlungen der Internationalen Vereinigung fur Theoretische und Angewandte Limnologie, Vol 13, p 252-263, 1958. 5 fig, 1 tab, 14 ref.

Descriptors: *Lakes, *Classification, *Lake morphometry, Dissolved solids, Depth, Temperature, Fish, Benthic fauna, Standing crop, Regression analysis.
Identifiers: Lake typology, British Columbia (Canada).

The analysis of lake survey data from British Columbia have indicated that the content of total dissolved solids (TDS) serves as the best index of production. No significant relationship was established between other factors, including mean depth, and standing crops of aquatic organisms. It is impossible to apply typological classification of lakes of British Columbia because paradox is the rule rather than the exception. Bearing in mind that total dissolved solids summarizes aspects of both the substrate and climate as well as their interaction, it should be the best single indicator of a large portion of the physical environment. (Wilde-Wisconsin)
W70-05566

'TROPHIC' TYPOLOGY VERSUS BIOTIC TYPOLOGY, AS EXEMPLIFIED IN THE REGIONAL LIMNOLOGY OF NORTHERN SPAIN,
Ramon Margalef.
Verhandlungen der Internationalen Vereinigung fur Theoretische und Angewandte Limnologie, Vol 13, p 339-349, 1958. 5 fig, 10 ref.

Descriptors: *Lakes, Lake morphology, Biota, Classification, Ecosystems, Plankton, Ecological distribution, Aquatic environments.
Identifiers: Regional limnology, Biotic typology, Spanish lakes, Baltic plankton, Caledonian plankton, Biocoenoses.

The population of every mass of water is considered as a biocoenose composed of a number of associations characterized by the frequency of occurrence of species having indicator value. The uniformity of composition of the terminal biocoenoses defines limnological regions. Over 2000 inventories, taken chiefly in the northern parts of Spain and Balearic Islands, delineated a number of limnological regions; their characteristics are outlined in tabular form. The relationships between trophic and biotic classificational approaches are questioned, as well as oligotrophic-entrophic ratings, biotic content of biotopes, and productive capacity of water basins, the problems which are too well known to students of terrestrial biocoenology. (Wilde-Wisconsin)
W70-05567

FAYETTEVILLE GREEN LAKE, NEW YORK. I. PHYSICAL AND CHEMICAL LIMNOLOGY,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences; and Massachusetts Univ., Amherst. Dept. of Zoology.
G. J. Brunskill, and S. D. Ludlam.
Limnology and Oceanography, Vol 14, No 6, p 817-829, 1969. 9 fig, 7 tab, 40 ref.

Descriptors: *Lakes, *New York, *Meromixis, Bathymetry, Electrical conductance, Chemical stratification, Heat budget, Chemical analyses, Geology, History, Lake morphology, Chara, Chlorophyta, Cyanophyta, Gastropods, Climatology, Chemocline, Rainfall, Evaporation, Hydrologic budget, Oxidation-reduction potential, Photosynthetic bacteria, Water chemistry, Sulfur bacteria, Dissolved solids.
Identifiers: *Fayetteville Green Lake (NY), *Physical limnology, *Chemical limnology, Mixolimnion, Monimolimnion, Meromictic stability, Round Lake (NY), Replentishment time, Sonar, Drepanocladus aduncus, Shoreline development, Volume development, Bacterial plate, Mesothermy, Chlorobium phaeobacteroides, Chromatium vinosum, Dichothermy.

Fayetteville Green Lake, New York, is a meromictic (chemically stratified) lake in which monimolimnetic:mixolimnetic molar ratios of dissolved ions are greater than unity and maximal for species (iron, manganese, ammonia) influenced by redox potential. Such ratios for sodium, potassium, lithium, boron, bicarbonate, total carbon dioxide, chloride, and bromide are in range, 1.8-2.9; calcium, magnesium, and sulfate are enriched in monimolimnion by factors, 1.1-1.3. Based upon aerial photographic survey and 103 sonar transects, a new bathymetric map and table are presented, from which were derived estimates of following morphometric parameters: total drainage area, lake surface area, mixolimnetic volume, maximum depth, mean mixolimnetic depth, length, breadth, shoreline length, shoreline development, volume development, mean slope, depth of center of gravity (CG), depth of mixolimnetic CG. Consideration of these and estimated density differential between mixolimnion and monimolimnion (0.0006 grams/cubic centimeter) yields estimate of meromictic stability (1700 gram-centimeters/square centimeter). Thermal profiles by time and depth reveal strikingly persistent discontinuities in chemocline region, attributable to absorption of solar radiation by well developed 'plate' of photosynthetic bacteria primarily pigmented sulfur bacteria. Analyses for 20 ions, total dissolved solids, and electrical conductance are also presented. (See also W70-05614). (Eichhorn-Wisconsin)
W70-05613

FAYETTEVILLE GREEN LAKE, NEW YORK. II. PRECIPITATION AND SEDIMENTATION OF CALCITE IN A MEROMICTIC LAKE WITH LAMINATED SEDIMENTS,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences.
G. J. Brunskill.
Limnology and Oceanography, Vol 14, No 6, p 830-847, 1969. 10 fig, 4 tab, 33 ref.

Descriptors: *Lakes, *New York, *Meromixis, *Sedimentation, *Chemical precipitation, *Calcite, Calcium, Hydrogen ion concentration, Carbonates, Gas chromatography, X-ray diffraction, Stokes' law, Sedimentation rates, Nitrogen, Sulfur, Phosphorus, Silicon, Iron, Carbon dioxide, Magnesium, Water chemistry, Chemical analyses, Temperature, Primary productivity, Algae, Photosynthesis, Chara, Daphnia, Organic matter.
Identifiers: *Fayetteville Green Lake (NY), *Laminated sediments, Titration alkalinity, Mixolimnion, Monimolimnion, Acid insoluble organic carbon, Acid insoluble nitrogen, Chemocline, EDTA titration techniques, Saturometry, Bacterial plate, Debye-Huckel equation, Activity coefficients, Carbonate equilibria, Crystal loads, Daphnia pulex, Physical chemistry.

Sediments of meromictic Fayetteville Green Lake, New York, are deposited annually in couplets of light and dark laminae, which probably reflect seasonal differential between precipitation rate of calcite and deposition rate of organic matter. Seasonal measurements of pH, temperature, calcium and titration alkalinity permitted calculation of calcium and carbonate activities. Based upon these data and thermodynamics of carbonate equilibria, detailed method of correcting for existing ion-pair interactions is described which yields estimates of calcite equilibrium activity product (K) and observed ion activity products (IAP) for calcium- and carbonate-ion. Ratio, IAP:K, estimates departure from calcite saturation, values exceeding unity indicating supersaturation. While internally generated calcite supersaturates water column throughout year, IAP:K at surface increases from winter values (2-4) to 6-8 during May-October, largely due to thermal effects on equilibria. Calcite precipitates massively during May-August, epilimnetic decreases in carbon dioxide indicating precipitation of 230 grams calcite/square meter per year upon bottom within 45-meter contour. Crystals settle 2-4 meters/day, consistent with rates calculated from Stokes' Law for observed particle sizes. Couplet production will probably continue so long as hydrologic and chemical budgets persist, meromictic stability exceeds wind work, and climate provides seasonal thermal differentials. (See also W70-05613). (Eichhorn-Wisconsin)
W70-05614

COMPREHENSIVE STUDY ON PROTECTION OF WATER RESOURCES OF LAKE TAHOE BASIN THROUGH CONTROLLED WASTE DISPOSAL,
Engineering-Science, Inc., Arcadia, Calif.; and Engineering-Science, Inc., Oakland, Calif.
P. H. McGauhey, Rolf Eliassen, Gerard Rohlich, Harvey F. Ludwig, and Erman A. Pearson.
Lake Tahoe Area Council, California, June 1963. 163 p, 93 fig, 107 tab, 105 ref, 9 append.

Descriptors: *Lakes, *Eutrophication, *Water resources, *Watershed management, *Waste disposal, California, Nevada, Planning, Hydrologic data, Land use, Climatology, Geology, Human population, Water utilization, Sewage treatment, Diversion, Distillation, Limnology, Design criteria, Costs, Analytical techniques, Data acquisition, Nutrients, Temperature, Phytoplankton, Chemical analysis, Water pollution control, Periphyton, Primary productivity.
Identifiers: *Lake Tahoe (Calif), *Lake Tahoe (Nev), Lake Tahoe Area Council, Geography, Plant nutrients.

The Lake Tahoe shore development for recreational purposes, one of the world's clearest lakes, has increased resident human population and subjected it to aggravated eutrophication influences. This detailed base line study was undertaken to determine resources of basin, evaluate its present status, and suggest programs to avoid further deterioration. Topical coverage of 16 chapters indicates its scope: introduction; geography of basin; climatology and hydrology; geology and hydrology; land use patterns; population forecasts; water consumption; existing sewerage facilities; quantity and characteristics of wastes; ground disposal studies; limnology and hydrography of Lake Tahoe, lacustrine eutrophication; methods of effluent disposal; design criteria and cost estimating bases; alternative treatment and disposal systems; summary and conclusions. Nine appendices include: list of figures; proposed compact terms for Tahoe basin; glossary of limnological terms; analytical methods used; temperature measurements; microplankton analyses; chemical characteristics; periphytic microorganisms; primary productivity measurements. These studies suggest that Lake Tahoe is very sensitive to additions of plant nutrients, and that additional nitrogen will be more damaging to its water quality than phosphorus. Ideally, control of eutrophication should be accomplished by diversion of effluents from the lake, or by distillation of secondary effluents--at great expense. (Eichhorn-Wisconsin)
W70-05615

A STUDY OF THE ONSET OF WHITECAPPING WITH INCREASED SURFACE WIND SPEEDS,
Northern Michigan Univ., Marquette. Dept. of Physics.
Edward C. Monahan.
Available from the Clearinghouse as AD-807 463, $3.00 in paper copy, $0.65 in microfiche. Feb, 67. 31 p.

Descriptors: *Waves, *Lakes, Lake breezes, *Wind, Velocity, Bubbles, Hydrography, Salinity, Photography, Water temperature.
Identifiers: Whitecap project, Lake Superior, Naugatuck vessel, Air water interactions, Tugs.

At present, the existence of abrupt changes in the physical character of the sea surface at certain wind speeds is indicated by measurements of certain surface related quantities while measurements of other such quantities indicate only smooth transitions in the nature of the sea surface. The data currently available on the occurrence of whitecaps, one measure of the character of the sea surface, are contradictory. It is the purpose of this study to investigate the onset of whitecapping as a function of wind speed, atmospheric stability, and water temperature in order to determine whether the concentration of whitecaps increases abruptly with wind speed, in which case it will be of interest to see how this critical wind speed varies with atmospheric stability and water temperature or whether whitecap concentration increases slowly with wind speed.
W70-05621

MODELING OF THE GREAT LAKES WATER SYSTEM,
Illinois Univ., Urbana. Dept. of Civil Engineering.
Dale D. Meredith.
Water Resources Bulletin, Vol 6, No 1, p 55-64, January-February 1970. 10p, 2 fig, 1 tab, 33 ref. OWRR Project B-035-ILL.

Descriptors: *Great lakes, *Limnology, *Model studies, *Systems analysis, Mathematical mocels, Hydraulic models, Hydraulic similitude, Hydrology, Water balance, Hydrologic budget, Simulation analysis, Synthetic hydrology.
Identifiers: *Lake models.

Two predominate approaches to the modeling of the Great Lakes water system include physical models and mathematical models. The physical models have been of individual lakes whereas the mathematical models have varied from models of individual processes such as evaporation occurring in one portion of one lake to models which include all water quantity components for all given Great Lakes. The assumptions and limitations of the two approaches are presented along with the kinds of results to be expected from each type of modeling. Examples of previous modeling efforts are given to illustrate these assumptions, limitations, and results. Other areas requiring further research are outlined. (Knapp-USGS)
W70-05633

THE RELATION OF PHYTOPLANKTON PERIODICITY TO THE NATURE OF THE PHYSICOCHEMICAL ENVIRONMENT WITH SPECIAL REFERENCE TO PHOSPHORUS. I. MORPHOMETRICAL, PHYSICAL AND CHEMICAL CONDITIONS,
Michigan State Univ., East Lansing.
For primary bibliographic entry see Field 02K.
W70-05647

THE RELATION OF PHYTOPLANKTON PERIODICITY TO THE NATURE OF THE PHYSICOCHEMICAL ENVIRONMENT WITH SPECIAL REFERENCE TO PHOSPHORUS. II. SEASONAL AND VERTICAL DISTRIBUTION OF THE PHYTOPLANKTON IN RELATION TO THE ENVIRONMENT,
Michigan State Univ., East Lansing.
For primary bibliographic entry see Field 02K.
W70-05648

LATE-PLEISTOCENE CLIMATIC CHANGES INFERRED FROM THE STRATIGRAPHIC SEQUENCES OF JAPANESE LAKE SEDIMENTS,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
For primary bibliographic entry see Field 02J.
W70-05654

THE RATIONALE OF PALEOLIMNOLOGY,
Indiana Univ., Bloomington. Dept. of Zoology.
David G. Frey.
Mitteilungen Internationale Vereinigung fur Theoretische und Angewandte Limnologie, Vol 17, p 7-18, 1969. 50 ref.

Descriptors: *Lakes, *Paleolimnology, Eutrophication, Sediments, Limnology, Sediment-water interfaces, Geomorphology, Chemical properties, Marl, Iron, Bacteria, Sedimentation, Pollen, Diatoms, Phytoplankton, Water chemistry, Diagenesis, Nutrients, Organic matter, Hydrology, Palynology, Stratigraphy, Oligotrophy, Bioindicators, Lake morphology, Climates, Michigan, Connecticut.
Identifiers: Current transport, Biological processes, Dy, Cladocera, Primary sedimentation, Secondary sedimentation, Lakes (Germany), Lakes (Ontario), Lakes (Switzerland), Lakes (England), Lakes (South America), Annual laminae, Laurentian Great Lakes, Old lakes, Evaporites, False bottom, Chronology, Fossil remains, Isotopes.

Lakes are sensitive integrators of chemical, physical, biological, and climatological processes occurring in them and influencing their basins. Among the synthesis of sciences constituting limnology, paleolimnologists must consider the added dimension of time in interpreting evidence bearing on lake history. Although laminate strata may reveal discrete temporal variations in sedimentation, the more usual condition is the blurring of sharp boundaries by retransport and secondary deposition. Accumulated lacustrine sediments are also modified by biological and chemical processes, and differential transport by currents and turbulence. A basic assumption of paleolimnology is that detailed study of many diverse characteristics of sediments will permit understanding of past climates, watershed conditions, water budgets, nutrient budgets, productivity, and the course of eutrophication. Organic compounds identified from lake sediments are numerous and diverse, and certain of them provide explicit information on the origin and productivity of specific organisms or groups or organisms. Morphological remains of a large variety of organisms (particularly diatoms, plant pollens, and cladocerans) constitute a fossil record which--however incomplete--permits meaningful interpretation of past conditions. Study of isotopes and isotope ratios in sediments also provides insights into lake metabolism history and microbial ecology. (Eichhorn-Wisconsin)
W70-05657

CULTURAL EUTROPHICATION WITH SPECIAL REFERENCE TO LAKE WASHINGTON,
Washington Univ., Seattle. Dept. of Zoology.
For primary bibliographic entry see Field 05C.
W70-05663

MUD LAKE, FLORIDA: ITS ALGAE AND ALKALINE BROWN WATER,
Geological Survey, Washington, D.C.; and Geological Survey, Ocala, Fla.
W. H. Bradley, and M. E. Beard.
Limnology and Oceanography, Vol 14, No 6, p 889-897, 1969. 4 fig, 1 tab, 9 ref.

Descriptors: *Lakes, *Florida, *Algae, *Alkaline water, Fishes, Water chemistry, Color, Chemical analyses, Hydrogen ion concentration, Iron, Manganese, Spectrophotometry, Calcium, Copper, Phosphates, Cobalt, Molybdenum, Temperature, Sulphates, Chlorides, Boron, Cyanophyta, Midges, Chlorophyta, Diatoms, Dystrophy, Physiological ecology, Magnesium, Sodium, Potassium, Fauna, Primary productivity.
Identifiers: *Mud Lake (Fla), *Brown water, Fecal pellets, Lake sediments, Zinc, Pistia, Specific conductance, Humic material, Macrophytes, Bacterial inhibitors, Eunotia, Coelosphaerium, Spirulina, Coccochloris, Anacystis, Schizothrix, Algal blooms, Sirogonium, Spirogyra, Stauroneis.

Mud Lake, Florida, is interesting because of its unusual biota, and its extensive sedimentary accumulation of algal ooze, which may represent a modern analogue of geological precursors of oil shale formations. Bottom layer of algal residues, about 1 meter thick, has been accumulating about 3000 years and constitute an energy sink, air-dried samples yielding 6600 calories/gram upon combustion. Ooze forms largely from blue-green algal (cyanophyte) remains in fecal pellets of midge larvae. This shallow lake (mean depth, less than 50 centimeters) has alkaline (pH, 7.7-10-2) water, seasonally colored brown, probably by humic materials originating from adjacent, frequently-flooded, mixed hardwood flora. Primary production derives from a benthic zone and a peripheral floating mat, incorporating flowering plants and a complex algal community. Benthos is dominated by diverse, bottom-dwelling flora of diatoms and cyanophytes, although erratic, massive blooms of

filamentous green algae occur, perhaps controlled by variations in phosphate concentrations, and optimal conditions of temperature and irradiance. True zooplankton and phytoplankton are nearly non-existent. A demonstrable antibacterial agent dissolved in lake's water probably functions to maintain the extremely sparse bacterial population there and at sedimental surface. Faunal inventory and monthly details of a water chemistry study are presented. (Eichorn-Wisconsin)
W70-05666

THE ROLE OF LARVAL CHIRONOMIDAE IN THE PRODUCTION OF LACUSTRINE COPROPEL IN MUD LAKE, MARION COUNTY, FLORIDA,
Indiana Univ., Bloomington. Dept. of Zoology; and Geological Survey, Washington, D.C.
A. J. Iovino, and W. H. Bradley.
Limnology and Oceanography, Vol 14, No 6, p 898-905, 1969. 9 fig, 1 tab, 15 ref.

Descriptors: *Lakes, *Florida, *Larvae, Sediments, Benthos, Wyoming, Oil shale, Water chemistry, Chlorophyta, Cyanophyta, Diatoms, Diagenesis, Radioactive dating, Animals, Biomass, Chlorella, Growth stages, Fishes, Predation, Inhibitors.
Identifiers: *Mud Lake (Fla), *Copropel, *Chironomidae, Algal ooze, Fossils, Feeding habits, Pistia, Procladius, Tanytarsus, Spirogyra, Sirogonium, Schizothrix, Coccochloris, Anacystis, Spirulina, Chironomine midges, Orthocladine midges, Tanypodine midges, Gloeocapsa, Chlorellin, Gosiute lakes, Vinta lakes.

Sediments of Mud Lake, Florida, are organic oozes, composed almost exclusively of cyanophyta cells (blue-green algae) contained within or growing upon fecal pellets of larval midges. Ooze is about 1 meter thick and, as determined from radiocarbon dating, has been accumulating some 3000 years. Compared with other north temperate lakes, midge populations here--primarily an undetermined species of Chironomus--are small (mean numbers for four dates during 12 months, 120-580/square meter). Small populations may result from fish predation; and reduced diversity, from environmental stresses imposed by shallow, alkaline, brown water. Lake has virtually no plankton; benthic flora comprises a diverse and complex assemblage of cyanophytes, fewer diatoms, and erratic winter blooms of green algae (Spirogyra, Sirogonium). Laboratory experiments with midges demonstrated that: increased numbers of fecal pellets are produced when algal cells are in higher concentrations; pellets remain coherent and durable when larvae feed on cyanophytes but not on green algae; larvae revert from filter-feeding to grazing on fecal pellets when suspended cyanophyte cells become scarce. Presence of fecal pellets and remains of immature chironomids in some oil shales suggest relationship between copropel, as formed in Mud Lake, and Eocene precursors of Green River Formation oil shale. (Eichhorn-Wisconsin)
W70-05667

HYDRODYNAMIC INSTABILITY OF MISCIBLE FLUIDS IN A VERTICAL POROUS COLUMN,
Guelph Univ. (Ontario).
For primary bibliographic entry see Field 02F.
W70-05677

A METHODOLOGY FOR SELECTING AMONG WATER QUALITY ALTERNATIVES,
Florida Univ., Gainesville. Dept. of Environmental Engineering; and North Carolina Univ., Chaper Hill. Dept. of City and Regional Planning.
For primary bibliographic entry see Field 05G.
W70-05703

AQUATIC SCIENCES IN THE GREAT LAKES AREA.
For primary bibliographic entry see Field 09D.
W70-05738

WATERBLOOM FORMING BLUE-GREEN ALGAE IN NORWAY AND THEIR IMPORTANCE IN THE STUDY OF THE INFLUENCE OF CULTURE ON THE WATER RESOURCES (IN NORWEGIAN),
Norsk Institutt for Vannforskning, Blindern.
For primary bibliographic entry see Field 05C.
W70-05751

FAYETTEVILLE GREEN LAKE, NEW YORK. III. THE LAMINATED SEDIMENTS,
Massachusetts Univ., Amherst. Dept. of Zoology.
For primary bibliographic entry see Field 02J.
W70-05753

THE EFFECTS OF ARTIFICIAL ENRICHMENT OF A LAKE,
Commonwealth Scientific and Industrial Research Organization, Hobart (Australia). Div. of Fisheries and Oceanography.
A. Weatherley, and A. G. Nicholls.
Australian Journal Marine Freshwater Research, Vol 6, No 3, p 443-470, 1955. 10 fig, 6 tab, 34 ref, 2 plates, appendix.

Descriptors: *Lakes, Mud, Phytoplankton, Zooplankton, Growth rates, Fish, Phosphorus, Temperature, Chemical analysis, Trout, Oxygen, Hydrogen ion concentration, Alkalinity, Silts, Iron, Nitrogen, Organic matter, Amphipoda, Copepods, Diptera, Fertilizers, Aquatic plants.
Identifiers: *Artificial enrichment, Lake Dobson (Australia), Myriophyllym elatinoides, Isoetes, Lake Fenton (Australia), Pulmonata, Eulamellibranchia, Chironomidae, Plecoptera, Calanoid, Cyclopoids, Bottom fauna.

A Tasmanian highland lake of low natural productivity was enriched by addition of a mixture of chemicals. The first application, to the mud, stimulated the existing stunted aquatic vegetation to produce a prolifivc growth; a latter application, broadcast over a portion of the lake, additionally increased phytoplankton and zooplankton. Concurrent with the plant growth was a marked increase in the total numbers of epiphytic fauna. Fish living in the lake at the time of enrichment showed a marked increase in growth rate, and others released later showed a similar response. It is tentatively concluded that phosphorus was the element responsible for the stimulus to the growth of plants and plankton. Phosphorus, of acknowledged importance in plant nutrition, is the element which bears the most striking relationship to where the plants came from and their mode of growth. It now appears unlikely that nitrogen deficiency might have been one of the limiting factors to plant development. The chief effect of adding fertilizer has been to induce a flourishing growth of aquatic plants. It is shown that an unproductive lake of this type can, by suitable enrichment, be rendered capable of carrying a fish stock. (Jones-Wisconsin)
W70-05754

PROGRESSIVE CHANGES IN THE CLADOCERAN AND MIDGE FAUNA DURING THE ONTOGENY OF ESTHWAITE WATER,
Indiana Univ., Bloomington.
For primary bibliographic entry see Field 05C.
W70-05755

THE DISTRIBUTION AND PERIODICITY OF THE PHYTOPLANKTON OF THREE CEYLON LAKES,
London Univ. (England).
E. C. T. Holsinger.
Hydrobiologie, Vol 7, p 25-35, 1955. 3 fig, 1 tab, 10 ref.

Descriptors: *Phytoplankton, *Distribution, *Lakes, Cyanophyta, Diatoms, Temperature, Productivity, Rainfall, Solar radiation, Water circulation, Organic matter, Soil texture, Mountains, Sampling, Nitrogen, Conductivity, Calcium, Hydrogen ion concentration, Water pollution, Chrysophyta.
Identifiers: *Periodicity, *Ceylon, Oscillatoria, Lyngbya, Microcystis aeruginosa, Desmids, Beira Lake (Ceylon), Nuwara Wewa Tank (Ceylon), Gregory Lake (Ceylon), Melosira ambigua, Melosira granulata, Arthrospira platensis, Chlorococcales, Staurastrum.

The phytoplankton of three Ceylon lakes, two situated in the warm lowlands and one in the mountains, was investigated. Certain similarities and differences regarding growth, distribution and periodicity of the plankton algae are related to environmental conditions. The lowland lakes are dominated by Cyanophyta which form 95% and 87% of the phytoplankton respectively, while in the mountain lake, which is temperate rather than tropical, diatoms for 65% of the phytoplankton. One of the lowland lakes lying in the center of densely populated city of Colombo has an algal productivity 2-1/2 times as great as the other, situated in a vast area of uncultivated land. The mountain lake, surrounded by cultivated hills, occupies an intermediate position between the low country lakes in regard to productivity. The environmental factors affecting algal growth, distribution and periodicity are temperature, rainfall, sunshine, movement of the water, amount of influx of organic matter and nature of the surrounding soil. In assessing the effect of rainfall, consideration has been given not only to the total precipitation, but also to its intensity and the occurrence of periods of drought. (Jones-Wisconsin)
W70-05756

FAYETTEVILLE GREEN LAKE, NEW YORK. IV. INTERSTITIAL WATER CHEMISTRY OF THE SEDIMENTS,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences; and Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 02J.
W70-05757

STUDIES ON THE SEDIMENTARY, ACID-SOLUBLE ORGANIC MATTER FROM LAKE MAGGIORE (NORTH ITALY). I. HETEROGENEITY AND CHEMICAL PROPERTIES OF A FRACTION PRECIPITATED BY BARIUM IONS,
Istituto Italiano di Idrobiologia, Pallanza.
For primary bibliographic entry see Field 02J.
W70-05759

FAYETTEVILLE GREEN LAKE, NEW YORK. V. STUDIES OF PRIMARY PRODUCTION AND ZOOPLANKTON IN A MEROMICTIC MARL LAKE,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences.
D. A. Culver, and G. J. Brunskill.
Limnology and Oceanography, Vol 14, No 6, p 862-873, 1969. 7 fig, 4 tab, 26 ref.

Descriptors: *Lakes, *New York, *Meromixis, *Primary productivity, *Zooplankton, Sulfur bacteria, Diel migration, Carbon dioxide, Hydrogen ion concentration, Phosphates, Nitrates, Daphnia, Silica, Thermal stratification, Sulfides, Ammonium compounds, Oxidation reduction potential, Dissolved oxygen, Chemical analysis, Organic matter, Algae, Iron, Hydrogen sulfide, Cyanophyta, Chlorophyta, Light penetration.
Identifiers: *Fayetteville Green Lake (NY), *Marl lakes, Chlorobium, Filinia, Monimolimnion, Chemocline, Mixolimnion, Radiocarbon uptake techniques, Bacterial plate, Bacterial pigments, Diaptomus, Epischura, Orthocyclops, Keratella, Polyarthra, Conochilus, Pycnocline, Photolithotrophic bacteria, Desulfovibrio, Mesothermy, Melosira, Synedra, Rhodomonas, Cyclotella, Chromatium.

Meromixis of Fayetteville Green Lake, New York, influences its trophic structure in the sense that bacterial primary production resembles total primary production in eutrophic lakes, while algal production is more oligotrophic. Seven determinations of radiocarbon uptake in light and dark bottles were made between October 1966 and the following July. Annual primary production was estimated at 290 grams carbon/square meter, of which approximately 83% was bacterial, primarily due to well developed plate of photosynthetic sulfur oxidizers in the chemocline (18-20 meters). Algal productivity may be limited by unfavorable ratio, monovalent cations:divalent cations, which has value of 0.06 in this lake, whereas higher ratios, in range 2-30, are considered optimal. Zooplanktonic biomass was dominated by copepods. Dense concentrations of zooplankters occur near the bacterial plate, where they probably feed on bacteria or on mixolimnetically produced seston, which tends to accumulate in the chemocline. Quantitative sampling of zooplankton with Clarke-Bumpus sampler yielded evidence for diel migrations of many species. (Eichhorn-Wisconsin)
W70-05760

THE EUTROPHICATION OF LAKES AND THE RADICAL CHANGE OF THEIR MATERIAL CONTENT (IN GERMAN),
For primary bibliographic entry see Field 05C.
W70-05761

EFFECTS OF RESERVOIR IMPOUNDMENT ON WATER QUALITY,
Corps of Engineers, Savannah, Ga. Special Programs Section.
For primary bibliographic entry see Field 05C.
W70-05883

2I. Water in Plants

UPTAKE OF ORGANIC SUBSTANCES FROM SOIL ORGANIC MATTER BY PLANT AND THEIR INFLUENCE ON METABOLISM,
Institut fuer Biochemie des Bodens der Forschungsanstalt fuer Landwirtschaft, Brunswick (West Germany).
W. Flaig.
Pontificiae Academiae Scientarum Scripta Varia, Vol 32, p 1-48, 1968. 12 fig, 2 tab, 112 ref.

Descriptors: *Organic compounds, *Plant growth, *Metabolism, *Phenols, Lignin, Degradation, Synthesis, Carbon dioxide, Plant physiology, Plant growth substances, Climates, Iron, Phosphorus, Potassium.
Identifiers: *Increased uptake, *Sugar metabolism, Indol-acetic acids, Antibiotics, Citric acid cycle, Endoxidation, Transamination, Sauerbeck-Fuhr-Harms experimental designs.

The 'humus effect' is not confined to physical and chemical properties of soils, but is also important in biochemical processes of plants. This is particularly true of phenols and their oxidation products, polymers formed in degradation of lignin, and indol-acetic acids. The phenolic compounds are largely transformed into glucose esters and glucosides inside the plant; some of these are decarboxylated. Added amino-acids undergo transformations. The uptake and transport of physiologically active organic substances are influenced by environmental conditions and require energy in amounts comparable to those involved in uptake and transfer of nutrient ions. The effect of organic substances on the growth of plants may be better explained by uncoupling of oxidative phosphorylation than by their influence on synthesis of nucleic acids and proteins. The favorable influence of physiologically active organics attains particular importance under unfavorable climatic conditions. The report probes into an old mystery of humus and indirectly stresses the importance of rhizospheric microorganisms. (Wilde-Wisconsin)
W70-05555

CONTINUOUS MONITORING OF SOIL MOISTURE TENSION PROFILES,
Agricultural Research Service, Fresno, Calif. Soil and Water Conservation Research Div.; and Nevada Bureau of Mines, Reno. Desert Research Inst.
W. C. Bianchi, and Rhys Tovey.
American Society of Agricultural Engineers, Transactions, Vol 11, No 3, p 441-443, 447, May-June 1968. 10 fig, 6 ref.

Descriptors: *Moisture tension, *Monitoring, *Measurement, *Tensiometers, *Equipment, Irrigation, Tension, Soil moisture, Soil water, Strain gages, Lysimeters, Manometers, Instrumentation, Calibrations, On-site data collections, Pressure, Electrical equipment.
Identifiers: *Soil moisture tension, *Pressure transducers, *Transducers, Scanning systems.

Although conventional gage or manometer-type tensiometers cannot be used for long-term measurement of changes in soil moisture tension, pressure transducers can be effectively employed. Minimum-cost hydraulic scanning and electronic scanning systems were studied and soil moisture tensions under irrigated alfalfa were measured. Multipoint electronic scanning of many individual strain-gage tensiometers yielded reliable field data throughout the growing season. In order to attribute soil moisture tension changes directly to changes in evapotranspiration, it is necessary to thermally isolate the measurement system. Zero shift of the transducers is the most important limitation of the pressure transducer system. External means of zero calibration are required, such as raising or creating a water table above transducers in lysimeters. (Carr-Arizona)
W70-05592

THE EFFECT OF WATER STRESS ON TRANSLOCATION IN RELATION TO PHOTOSYNTHESIS AND GROWTH: I. EFFECT DURING GRAIN DEVELOPMENT IN WHEAT,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Plant Industry.
I. F. Wardlaw.
Australian Journal of Biological Sciences, Vol 20, No 1, p 25-39, February 1967. 4 fig, 6 tab, 49 ref.

Descriptors: *Moisture stress, *Translocation, *Photosynthesis, *Plant growth, *Wheat, Leaves, Stomata, Crop response, Wilting, Moisture deficit, Turgidity, Light, Plant physiology, Velocity, Growth stages, Carbon dioxide.
Identifiers: *Carbon 14, *Assimilates, *Grain growth.

Wheat plants were placed under water stress 15-20 days after anthesis. During the stress period rate of photosynthesis and translocation of assimilates were studied. There was progressive reduction in photosynthesis rate after the onset of wilting and rate of wilted leaves was lower than that of turgid leaves. Several days of leaf wilting did not effect grain growth, as assimilates were redistributed from the lower parts of the plant to the grain. Stress had little effect on the velocity of translocation, but movement of assimilates into conducting tissues was prolonged in wilted leaves. It would appear from these results that water stress acts directly on the leaf, rather than indirectly through growth or sugar movement. (Carr-Arizona)
W70-05603

CROP YIELD RESPONSE TO NONUNIFORM APPLICATION OF IRRIGATION WATER,
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 03F.
W70-05604

VEGETATIONAL MAP AND COMMUNITY STRUCTURE OF A WEST CENTRAL KANSAS PRAIRIE,
Fort Hays Kansas State Coll., Hays. Div. of Biological Sciences.
Rodney K. Heitschmidt, G. K. Hulett, and G. W. Tomanek.
The Southwestern Naturalist, Vol 14, No 3, p 337-350, January 15, 1970. 2 fig, 3 tab, 22 ref.

Descriptors: *Soil moisture, *Grasslands, *Plant groupings, *Mapping, *Kansas, Semiarid climates, Soils, Soil types, Topography, Maps, Wheatgrasses, Vegetation, Plant populations, Soil moisture, Soil-water-plant relationships, Soil profiles, Sampling, Plant populations.
Identifiers: *Vegetational communities, *Soil moisture gradient.

A study was undertaken to outline cartographically vegetational communities on a 176-acre prairie in western Kansas. Vegetational structure, topographic position, and underlying soils were used to characterize the seven recognized communities. These communities were classified as: Buchloe-Bouteloua, Buchloe-Bouteloua-Agropyron, Bouteloua, Bouteloua-Andopogon, Andopogon gerardi, Andopogon scoparius, and Kochia. Soil moisture gradient, resulting from combined effects of topography and soils, was found to be the primary determinant of the communities. (Carr-Arizona)
W70-05612

STOMATAL CLOSURE IN CONIFER SEEDLINGS IN RESPONSE TO LEAF MOISTURE STRESS,
Forest Service (USDA), Wenatchee, Wash. Pacific Northwest Forest and Range Experiment Station.
William Lopushinsky.
Botanical Gazette, Vol 130, No 4, p 258-263, 1969.

Descriptors: *Stomata, *Moisture stress, *Transpiration, *Transpiration control, Conifers, Soil moisture, Soil-water-plant relationships, Ponderosa pine trees, Lodgepole pine trees, Douglas-fir trees, Grand fir trees.
Identifiers: Engelmann spruce trees.

Water content and water stress of foliage at stomatal closure were determined for 3-year-old seedlings of ponderosa pine, lodgepole pine, grand fir, Douglas-fir, and Engelmann spruce. Stomatal behavior during increasing soil drought was interpreted from transpiration trends of seedlings kept under controlled conditions, and degree of stomatal opening was determined with a pressure infiltration technique. At stomatal closure, needle water contents ranged from 122% to 162% and were lowest in Engelmann spruce and Douglas-fir, intermediate in the pines, and highest in grand fir. Needle relative turgidity ranged from 81% to 86% with little difference between species, and leaf moisture stress ranged from 14 to 25 atmospheres. The pines and spruce had the lowest stress, indicating that the stomata of these species were more sensitive to increasing leaf moisture stress than those of the firs. Transpiration-decline curves obtained with excised twigs indicated that stomatal closure occurred more rapidly in the pines and spruce than in the firs. (Lopushinsky-USFS)
W70-05617

AN ANALYSIS OF THROUGHFALL AND STEMFLOW IN MIXED OAK STANDS,
Rhode Island Univ., Kingston; and Essex Agricultural and Technical Inst., Hathorne, Mass.
James H. Brown, Jr., and Albert C. Barker, Jr.
Water Resources Research, Vol 6, No 1, p 316-323, February 1970. 8 p, 4 tab, 11 ref. OWRR Project A-001-RI.

Descriptors: *Interception, *Stemflow, *Throughfall, *Oak trees, Statistical methods, Canopy, Regression analysis, Precipitation (Atmospheric), Vegetation effects, Rainfall-runoff relationships.
Identifiers: Greenwich (R.I.).

Net rainfall was studied under immature stands of mixed oak in southern New England. Throughfall did not differ significantly between stands. Stemflow was measured from all trees on one-fortieth-

acre plots. Although yields varied greatly between plots, plot sampling of stemflow within 15% error tolerance was considered practical in most mixed oak stands. Both average dbh of dominant and codominant trees on stemflow plots and plot basal area showed high positive correlations with stemflow. Analysis of individual stems showed species and dbh highly correlated with stemflow. Black oaks yielded more stemflow than white oaks. The only storm characteristic significantly correlated with stemflow was storm size. Stemflow was greater during the dormant season. (Knapp-USGS)
W70-05634

EFFECTS OF KAOLINITE AS A REFLECTIVE ANTITRANSPIRANT ON LEAF TEMPERATURE, TRANSPIRATION, PHOTOSYNTHESIS, AND WATER-USE EFFICIENCY,
California Univ., Davis.
For primary bibliographic entry see Field 2D.
W70-05635

2J. Erosion and Sedimentation

FAYETTEVILLE GREEN LAKE, NEW YORK. II. PRECIPITATION AND SEDIMENTATION OF CALCITE IN A MEROMICTIC LAKE WITH LAMINATED SEDIMENTS,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences.
For primary bibliographic entry see Field 02H.
W70-05614

THE STRENGTH AND CREEP OF FROZEN SOILS AND CALCULATIONS FOR ICE-SOIL RETAINING STRUCTURES,
Cold Regions Research and Engineering Lab., Hanover, N.H.
S. S. Vyalov, V. G. Gmoschinskii, S. E. Gorodetski, V. G. Grigorieva, and Yu K. Zaretski.
Available from the Clearinghouse as AD-484 093, $3.00 in paper copy, $0.65 in microfiche. CREL-Trans-76, Sep 65. 324 p.

Descriptors: *Frozen soils, *Soil strength, Walls, *Rheology, Deformation, Stress, Creep, Test procedures, Ice, Particle size.
Identifiers: Soil texture, Frost, Artifically frozen soils, USSR.

Since frozen soils are relatively strong and watertight, they may be used successfully as materials for various types of engineering construction. For example, artifically frozen soils may be used as retaining structures during mining and under complex hydrogeological conditions for sinking open-shafts. When plans and static calculations are being made for constructions on frozen soils, it is necessary to take into consideration the specific properties of such soils. The strength and deformation properties of frozen soils depend essentially upon soil-temperature, soil-composition, and soil-texture (grain-size distribution, moisture content, ice content, frost texture, etc.). Furthermore, the stress-deformation characteristics of frozen soils depend to a very large degree upon the time factor. Since ice and unfrozen water are present, the soils possess clearly defined rheological properties, such as increasing deformation with time (creep), and relaxation and reduction of strength. This book is devoted to the study of the rheological properties of frozen soils and to the development of methods for calculating creep and long-term strength of retaining structures made from artifically frozen soils.
W70-05625

SUBMARINE TOPOGRAPHY AND SEDIMENTATION IN THE VICINITY OF MUGU SUBMARINE CANYON, CALIFORNIA,
Corps of Engineers, Washington, D.C. Beach Erosion Board.
D. L. Inman.
Available from the Clearinghouse as AD-699 396, $3.00 in paper copy, $0.65 in microfiche. Beach Erosion Bd Rept no. TM-19 July, 1950, 50 p.

Descriptors: *Beaches, *Beach erosion, *Oceanography, Sedimentation, Sampling, Ocean currents, Sands.
Identifiers: Mugu Submarine Canyon, Ocean ridges.

Mugu Submarine Canyon resembles the subaerially eroded canyons inland except that the two branches at its head are somewhat unusual in having an isolated ridge protruding from the floor of each branch and parallel to the canyon axis. Cores indicate that there are hard rock outcrops at several points on the floor along the deeper portions of the canyon. The maximum gradient of the canyon occurs at its two heads and may represent the maximum angle of repose of recent fill. There are indications that the heads and sides of the submarine canyon are relatively unstable as compared to the more gently sloping shelf areas on either side of the canyon. The sediments on the shelf areas adjacent to the canyon show a somewhat systematic variation in type; however, the distribution of sediments from the floor and sides of the canyon is complex and not a function of depth. Analysis of the samples shows that the upper canyon sediments are poorly sorted and have an asymmetrical size distribution which differs from the well sorted and more symmetrical shelf sediments.
W70-05628

LATE-PLEISTOCENE CLIMATIC CHANGES INFERRED FROM THE STRATIGRAPHIC SEQUENCES OF JAPANESE LAKE SEDIMENTS,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
S. Horie.
Means of Correlation of Quaternary Successions, Vol 8, Proceeding 7, Congress International Association for Quaternary Research, University of Utah Press, Salt Lake City, p 311-324, 1968. 5 fig, 6 ref.

Descriptors: *Lakes, *Sediments, Stratigraphy, Climates, Glaciation, Eutrophication, Biomass, Nitrogen, Calcium carbonate.
Identifiers: Japanese lakes, Pleistocene, Ancient lakes, Ignition loss, Sea levels, Japanese coasts, Pre-Holocene lakes, Trophic stages, Yogo-ko (Japan), Kizaki-ko (Japan), Biwa-ko (Japan), Japan.

Cores of 2 to 10 meters in length were obtained with a Livingstone borer from the bottoms of Japanese lakes Yogo-ko, Kizaki-ko, and Biwa-ko. The latter is the largest Japanese lake and together with Lake Baikal, is the oldest lake of the world, aged about 10 million years. The cores, subjected to various analyses, revealed the periods of decreased precipitation during glacial interstadials and corresponding trophic-stage fluctuations. Since Wisconsin glaciation, sea level rose to a peak about 4,000 years ago, then dropped slightly, and finally rose to the present level. In spite of the marked instability of the earth's crust of the Japanese Islands, climatic changes appear to be more effective than crustal deformation as factors influencing lake trophy. The boundary between oligotrophy and mesotrophy or eutrophy was tentatively established at 0.25% of nitrogen in the mud on oven-dry basis. (Wilde-Wisconsin)
W70-05654

ACCUMULATION OF RADIONUCLIDES IN BED SEDIMENTS OF THE COLUMBIA RIVER BETWEEN THE HANFORD REACTORS AND McNARY DAM,
Battelle Memorial Inst., Richland, Wash., and Geological Survey, Portland, Oreg.
For primary bibliographic entry see Field 05B.
W70-05675

SEDIMENT IN RELATION TO WATER QUALITY,
Agricultural Research Service, Oxford, Miss. Sedimentation Lab.
For primary bibliographic entry see Field 05B.
W70-05705

PROFILES OF A REACH OF THE SAN JOAQUIN RIVER BELOW FRIANT DAM, FRESNO AND MADERA COUNTIES, CALIFORNIA,
Geological Survey, Menlo Park, Calif.
For primary bibliographic entry see Field 02E.
W70-05725

THE ROLE OF SECONDARY CURRENTS IN HYDRAULICS,
Pittsburgh Univ., Pa. School of Engineering.
For primary bibliographic entry see Field 02E.
W70-05743

SECONDARY CURRENTS IN THE NEWCASTLE HARBOUR SILTATION INVESTIGATION,
Department of Public Works, Sydney (Australia). Hydraulic Lab.; and Department of Public Works, Sydney (Australia). Maritime Service Board.
Arthur H. Lucas, and Peter B. Stone.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A56, p 456-464, 1967. 9 p, 8 fig, 3 tab, 2 ref.

Descriptors: *Density currents, *Turbidity currents, *Silting, *Harbors, Currents (Water), Water circulation, Channel morphology, Sediment load, Flocculation, Deposition (Sediments), Suspended load.
Identifiers: *Secondary currents, *Australia, Newcastle Harbor.

Secondary currents in the form of salinity density currents have a significant effect on the hydraulics and siltation of a harbor. As river fresh flow increases, these currents cause a considerable variation in the tidal exchange of basins off the main estuary of the Hunter River, Newcastle, N.S.W., Australia. The system of orders of aggregation of silts developed by Krone correlated well with the performance of silts from the harbor. This gave confidence to an analysis of siltation prediction which took into account the secondary currents caused by density differences in the basins. A comparison was made with an analysis in which no secondary currents were considered. The work was undertaken in an investigation into the siltation of Newcastle Harbor. The problem was the high and increasing cost of maintenance dredging in the shipping channels. To assist in understanding the harbor and to study proposed schemes a relationship was established between tidal discharge and the cross-sectional area of channels not requiring dredging. The steelworks Channel in the South Arm and Wickham Basin both had tidal discharges well below that required for a maintenance free condition. The investigation then attempted to evaluate the rate of siltation for various schemes with non-equilibrium conditions. For these conditions the secondary density currents, which cause increased tidal exchange, considerably influence the siltation. An evaluation is given of the changes in hydraulics and siltation brought about by a complete blockage of the South Arm upstream of the shipping channels. (Knapp-USGS)
W70-05746

THE MECHANICS OF DUNE FORMATION IN ERODIBLE-BED CHANNELS,
Public Works Research Inst., Tokyo (Japan).
Akihiko Tsuchiya, and Katsuyoshi Ishizaki.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A59, p 479-486, 1967. 8 p, 7 fig, 4 ref.

Descriptors: *Dunes, *Bed load, *Alluvial channels, Sediment transport, Sand waves, Waves (Water), Turbulence, Fluid mechanics, Mathematical studies, Model studies.
Identifiers: Erodible-bed channels.

Bed configuration in erodible bed channels varies according to the hydraulic conditions of flow and bed material. The mechanics of dune formation was analyzed by introducing the interaction between surface waves and sand waves on the bed. The compounding of several waves which are generated simultaneously in a channel and have different wave lengths could well illustrate the mechanics of dune formation. The height of dune was also analyzed in connection with bed load transportation. (Knapp-USGS)
W70-05748

THE STABLE PROFILES OF THE CURVED OPEN CHANNEL BEDS,
Public Works Research Inst., Tokyo (Japan).
Kyozo Suga.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A60, p 487-495, 1967. 9 p, 6 fig, 1 tab.

Descriptors: *Open channel flow, *Meanders, *Alluvial channels, Mathematical studies, Model studies, Sediment transport, Bed load, Equilibrium, Channel morphology.
Identifiers: Open-channel bend hydraulics.

Stable lateral bed profiles of continuous curved open channels, both in dynamic and in static equilibrium, were analyzed theoretically by some assumptions on the velocity and bed material load distributions in the bends, and the analyses were verified experimentally. Some characteristics of the stable plane profiles of the beds and of the flow in these states were also clarified by experiments of 33 cases using 11 kinds of curved channel. (Knapp-USGS)
W70-05749

FAYETTEVILLE GREEN LAKE, NEW YORK. III. THE LAMINATED SEDIMENTS,
Massachusetts Univ., Amherst. Dept. of Zoology.
Stuart D. Ludlam.
Limnology and Oceanography, Vol 14, No 6, p 848-857, 1969. 1 fig, 4 tab, 22 ref.

Descriptors: *Lakes, *New York, *Meromixis, *Sediments, Varves, Density currents, Sedimentation rates, Calcium carbonate, Analytical techniques, Organic matter, Snails, Marl, Erosion, Cores, Clays, Littoral, Calcite, Slopes, Turbidity currents.
Identifiers: *Fayetteville Green Lake (NY), *Laminated sediments, Bioherms, Chemocline, Manlius (NY), Dewitt (NY), Round Lake (NY), Jamesville Green Lake (NY), Turbites, Coupled laminae, Clastic matter, Surficial sediments, Birge-Ekman dredge, Mackereth cores, Varved beds.

As studied from dredge (Birge-Ekman) samples and cores (Mackereth), surficial sediments of meromictic (chemically stratified) Fayetteville Green Lake, New York, consist of alternating horizons of coupled laminae and unlaminated beds. Couplets, consisting of a basal pale layer and an overlying darker layer, are annually deposited varves, sedimentation of which is apparently controlled by seasonally differentiated rates of sedimentation of precipitated calcite and organic matter. Weight of sediment deposited per unit area in couplets yields deposition rates (in grams/square centimeter per year) of 0.07 for dry sediment and 0.05 for calcium carbonate. In more shallow, neck-like region of lake, couplets are sedimented only at depths greater than the chemocline. Unlaminated beds, massive and frequently graded in structure, result from deposition by density currents of heterogeneously derived materials which often originate in the littoral zone. Such sediments (turbidites) represent 40-65% of total sedimentary accumulation at depths greater than 25 meters. (Eichhorn-Wisconsin)
W70-05753

FAYETTEVILLE GREEN LAKE, NEW YORK. IV. INTERSTITIAL WATER CHEMISTRY OF THE SEDIMENTS,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences; and Florida State Univ., Tallahassee. Dept. of Oceanography.
Gregg J. Brunskill, and Robert C. Harriss.
Limnology and Oceanography, Vol 14, No 6, p 858-861, 1969. 1 fig, 2 tab, 5 ref.

Descriptors: *Lakes, *New York, *Meromixis, *Water chemistry, *Connate water, *Sediments, Salinity, Chemical analysis, Analytical techniques, Groundwater, Cores, Oxidation-reduction potential, Hydrogen ion concentration, Sodium, Magnesium, Calcium, Colorimetry, Silica, Chlorides, Fluorides, Calcite.
Identifiers: *Fayetteville Green Lake (NY), Chemocline, Mixolimnion, Diatom frustules, Monimolimnion, Aluminosilicate minerals, Ratio (Chloride:Sodium), Saline springs, Salina Formation halite beds, Strontium, Aragonite, Atomic absorption spectrophotometry, Specific ion electrodes, Bromides, Mineral-water equilibria.

Analyses of water expressed from sediment cores from Fayetteville Green Lake, New York, indicate that inflow of saline groundwater contributed importantly to origin of meromixis. Such influx, probably originating from underlying halite formations, undoubtedly helps maintain chemical stratification of lake. Interstitial water was analyzed for sodium, magnesium, strontium, and calcium by atomic absorption spectrophotometry; for silica by molybdate colorimetry; and for chloride, fluoride, and bromide with solid-state specific ion electrodes. In core taken from deep basin of lake, composition of interstitial water increases in sodium, magnesium, strontium, calcium, chloride, and bromide with depth. Similarly, small increases of the ratio, chloride:sodium, occur below sediment-water interface. Two cores from shallow areas contain water with composition similar to that of overlying lake water except for slight enrichment in bromide and silicate. Water of core from intermediate depth is influenced by chemocline, and analyses suggest that lateral migration and mixing of mixolimnetic and monimolimnetic water occurs in this region. Compared with overlying water, interstitial water is enriched in silica by factors in range, 1.1-14.4. Variations in silica are not consistently related to sediment texture or depth, and enrichment may arise from dissolution of diatom frustules or aluminosilicate minerals. (Eichhorn-Wisconsin)
W70-05757

STUDIES ON THE SEDIMENTARY, ACID-SOLUBLE ORGANIC MATTER FROM LAKE MAGGIORE (NORTH ITALY). I. HETEROGENEITY AND CHEMICAL PROPERTIES OF A FRACTION PRECIPITATED BY BARIUM IONS,
Istituto Italiano di Idrobiologia, Pallanza.
Domenico Povoledo, and Marco Gerletti.
Summary in Italian. Memorie dell'Istituto Italiano di Idrobiologia, Vol 17, p 115-150, 1964. 14 fig, 5 tab, 49 ref.

Descriptors: *Lakes, *Sediments, *Organic matter, Chromatography, Hydrolysis, Phosphates, Sodium compounds, Copper, Amino acids, Carbohydrates, Heterogeneity, Chemical analysis, Fluorescence, Analytical techniques.
Identifiers: *Lake Maggiore (Italy), Gel filtration, Sodium hydroxide, Barium precipitation, Lead precipitation, True fulvic acids, Folin-Ciocalteu phenol test, Orcinal test, Elution patterns.

Samples of sediments were collected from Lake Maggiore near Isola Madre, at 60 to 80 meter depths, far from polluted water. A combination of gel filtration chromatography and fractional precipitation by heavy metals permitted separation of several fractions of organic matter of lacustrine sediments. These fractions were subjected to acid hydrolysis and further investigated for their amino acid and monosaccharide constituents. The results confirmed that the acid soluble compounds, extractible from lake sediments by mild alkaline solutions, are not chemically homogeneous. The heterogeneity of the Ba-S solution was revealed not only by its gel filtration chromatographic behavior, but also by the presence of constituents of different nature: polyphenols, peptides, and polysaccharides. It appears that bacterial mucopolysaccharides contribute to their formation. These findings provide better understanding of problems linked with sedimentary organic matter. (Wilde-Wisconsin)
W70-05759

SEDIMENT MEASUREMENT TECHNIQUES: E. AIRBORNE SEDIMENT.
For primary bibliographic entry see Field 07B.
W70-05886

MINERALOGY OF THE SUSPENDED SEDIMENT IN THE TIGRIS, EUPHRATES, AND SHATT-AL-ARAB RIVERS OF IRAQ, AND THE RECENT HISTORY OF THE MESOPOTAMIAN PLAIN,
Baghdad Univ. (Iraq). Dept. of Geology.
Richard W. Berry, Gerald P. Brophy, and Adnan Naquash.
Journal of Sedimentary Petrology, Vol 40, No 1, p 131-139, March 1970. 9 p, 2 fig, 12 ref.

Descriptors: *Suspended load, *Clay minerals, *Provenance, Flood plains, Rivers, Mineralogy, Deposition (Sediments), Geophysics, Water chemistry, Sampling, Chemical analysis.
Identifiers: Tigris River, Euphrates River, Iraq.

Clay mineral fractions of the Euphrates and Tigris Rivers show marked differences related to the nature of the provenance area. The Euphrates is richer in both chlorite and expandable lattice clays. All the suspension load of the two rivers is deposited prior to entering the Persian Gulf. Minimum sediment accumulation in the lower Mesopotamian Plain is 0.1 cm/year, but if restricted to the marsh areas is 1.0 cm/year. Downwarp to form the present plain began in upper Miocene and is presently continuing. Marginal upwarping has occurred since human habitation of the region. (Knapp-USGS)
W70-05891

A NEW RECORDING TURBIDITY METER FOR RIVERS,
Natal Univ., Durban (South Africa).
For primary bibliographic entry see Field 07B.
W70-05901

2K. Chemical Processes

EFFECT OF LIGHT INTENSITY AND THICKNESS OF CULTURE SOLUTION ON OXYGEN PRODUCTION BY ALGAE,
Naval Research Laboratory, Washington, D.C. Chemistry Div.
R. L. Shuler, and W. A. Affens.
Applied Microbiology, Vol 19, No 1, p 76-86, 1970. 10 fig, 3 tab, 5 ref.

Descriptors: *Chlorella, *Light, *Photosynthetic oxygen, *Algae, Cultures, Volume, Mathematical studies, Correlation analysis.
Identifiers: *Chlorella pyrenoidosa, Oxygen production, Light intensity, Culture thickness, Culture volume.

Objective was to optimize oxygen production efficiency for use in closed systems, such as submarines. Mathematical relationship between oxygen production rate, by Chlorella pyrenoidosa

(Sorokin strain--optimum temperature 39C), light intensity, culture thickness, and volume of suspension were worked out using a single type culture vessel. The vessel was an upright cylinder with the incandescent light source (also an upright cylinder) located centrally. The culture medium was pumped through continuously. Culture cell densities of 0.5 to 1.55% wet packed cell volumes were such that experimental data were collected on light limited cells undergoing log growth. Light intensities of 12,000-70,000-foot candles were employed. Culture thickness was varied by the use of separate annular compartments around the single light source. Cooling water was pumped continuously in a layer between lamp and culture vessel so as to maintain temperature at 38.5C. The conclusion was that oxygen evolution rate was a log function of light intensity and that rate of oxygen evolution per unit volume of culture is related linearly to the reciprocal of culture thickness. The relationships cited for the cylindrical vessel may have wide applicability. Efficiencies with respect to electrical (light) requirements were computed. (Gerhold-Wisconsin)
W70-05547

HYDROCHEMICAL INTERPRETATION OF GROUNDWATER MOVEMENT IN THE RED RIVER VALLEY, MANITOBA,
Department of Energy, Mines and Resources, Ottawa (Ontario).
For primary bibliographic entry see Field 02F.
W70-05638

PROPERTIES OF TILE DRAINAGE WATER,
Iowa State Univ., Ames.
T. L. Willrich.
Available from the Clearinghouse as PB-191 064, $3.00 in paper copy, $0.65 in microfiche. Completion Report Iowa State Water Resources Research Institute, December 31, 1969. 39 p, 16 tab. Project No. A-013-IA.

Descriptors: *Nitrogen, *Nutrients, *Pesticides, Pollution, *Properties, Drainage, Phosphorus, Tile drainage, Water.

Water samples from 10 tile drainage outlets were collected and analyzed about twice a month whenever flow occurred. The drainage systems were located on commercial farms in the Clarion-Webster soil association area of north central Iowa. Drainage areas ranged from 6 to 366 acres. Major portions of all areas were intensively cropped. Corn and soybeans were the usual crops. Median values for properties tested routinely ranged as follows: total N - 12 to 27 mg/l, P - 0.1 to 0.3 mg/l, K - 0.2 to 0.8 mg/l, hardness - 350 to 440 mg/l as CaCO3, alkalinity - 260 to 330 mg/l as CaCO3, specific conductance - 350 to 460 micromhos/cm, and pH - 7.4 to 7.8. Practically all of the total N was in the nitrate form. Usual values for the other N fractions were: org. N - <0.05 mg/l, NH4-N - <0.10 mg/l, and NO2-N - <0.01 mg/l. Average annual amounts of N fertilizer applied during the 5 years ranged from 18 to 89 pounds per acre for the drainage areas studied. Factors in addition to the amounts of applied fertilizer influenced N concentrations in the drainage water based on comparisons of results obtained from all areas and of yearly results from the same areas. Properties tested occasionally included amounts of pesticide residues, chemical oxygen demand and sulfur. No chlorinated hydrocarbon residues were detected except as laboratory glassware contaminants. COD values ranged from 0 to 14 mg/l. Inorganic S values ranged from 10 to 40 mg/l.
W70-05642

THE RELATION OF PHYTOPLANKTON PERIODICITY TO THE NATURE OF THE PHYSICOCHEMICAL ENVIRONMENT WITH SPECIAL REFERENCE TO PHOSPHORUS. I. MORPHOMETRICAL, PHYSICAL AND CHEMICAL CONDITIONS,
Michigan State Univ., East Lansing.
Allan Tucker.
American Midland Naturalist, Vol 57, p 300-333, 1957. 8 fig, 13 tab.

Descriptors: *Chemical analysis, *Chemical properties, *Physical properties, Lakes, Nutrients, Phosphorus, Phosphorus compounds, Oxygen, Carbonate, Carbon dioxide, Bicarbonates, Conductivity, Hydrogen ion concentration, Temperature, Water chemistry, Water quality, Michigan phytoplankton.
Identifiers: Morphometry, Douglas Lake (Mich), Lancaster Lake (Mich), Munro Lake (Mich), Vincent Lake (Mich), Lake Lansing (Mich).

The results of physical and chemical studies on five morphometrically differing lakes (Douglas Lake, Lancaster Lake, Munro Lake, Vincent Lake, and Lake Lansing) in Michigan are reported. The data include seasonal and vertical distributions of temperature, conductivity, oxygen, free carbon dioxide, carbonates, bicarbonates, pH, and phosphorus. The phosphorus fractions analyzed are soluble inorganic phosphorus, organic phosphorus, and total phosphorus. (Koonce-Wisconsin)
W70-05647

THE RELATION OF PHYTOPLANKTON PERIODICITY TO THE NATURE OF THE PHYSICOCHEMICAL ENVIRONMENT WITH SPECIAL REFERENCE TO PHOSPHORUS. II. SEASONAL AND VERTICAL DISTRIBUTION OF THE PHYTOPLANKTON IN RELATION TO THE ENVIRONMENT,
Michigan State Univ., East Lansing.
Allan Tucker.
The American Midland Naturalist, Vol 57, p 334-370, 1957. 8 fig, 3 tab, 50 ref.

Descriptors: *Algae, *Phytoplankton, Nutrients, Phosphorus, Water quality, Distribution patterns.
Identifiers: Phytoplankton periodicity, Phytoplankton composition patterns, Morphometry.

Data from a qualitative and quantitative analysis of the seasonal and vertical distribution patterns of phytoplankton in five Michigan lakes are reported. The composition patterns of the phytoplankton are then compared to the physical and chemical conditions at the time of sampling. Little evidence could be derived that would indicate a strong predictive correlation between phosphorus concentrations and pulses in the phytoplankton population. The discussion also includes an extensive review of the literature on phytoplankton periodically available at the time of publication. (Koonce-Wisconsin)
W70-05648

RELATIVE QUANTUM EFFICIENCY OF VISIBLE AND INFRARED LIGHT ON PHOTOSYNTHETIC 02 PRODUCTION,
Research Lab. in Plant Physiology, Penningby (Sweden).
Henrik G. Lundegardh.
Proceedings of the National Academy of Sciences, USA, Vol 59, No 1, p 293-295, 1968. 3 fig, 2 tab, 3 ref.

Descriptors: *Oxygen, *Photosynthesis, Light, Color, Absorption, Wavelengths, Efficiencies, Chlorophyll.
Identifiers: Oxygen production, Quantum efficiency, Chloroplast isolation, Light absorption, Thermoelectric measurements, Schott filters, Einsteins, B + L monochromator, Verlauf filters, Infrared light, Beta-carotene.

Chloroplasts isolated from spinach were diluted for determination of oxygen production to concentration of 0.04-0.06 milligram/milliliter. The suspension was exposed to illumination with a variety of filters. The trials showed a rapid decline of the quantum efficiency (Qeff) from wavelength 700 to 800 nanometers, caused by the low absorption of chlorophyll and beta-carotene, and a decreasing photosynthetic activity of infrared quanta. The complete process of photosynthesis, however, may include participation of infrared radiation. (Wilde-Wisconsin)
W70-05659

THE PRIMARY PRODUCTION IN LAKES: SOME RESULTS AND RESTRICTIONS OF THE C14 METHOD,
Uppsala Univ. (Sweden). Inst. of Limnology.
Wilhelm Rodhe.
Rapport et proces verbaux des Reunions. Conseil Permanent International pour l'Exploration de la Mer, Vol 144, p 122-128, 1958. 5 fig, 1 tab, 7 ref.

Descriptors: *Primary productivity, *Lakes, *Carbon radioisotopes, *Radioactivity techniques, Tracers, Photosynthesis, Respiration, Fresh water, Saline water, Light intensity, Seasonal, Nannoplankton, Cyanophyta, Winds, Standing crop, Phytoplankton, Chemical analysis, Nutrients, Phosphates, Nitrates, Oligotrophy, Eutrophication.
Identifiers: *Carbon-14 tests, Lake Erken (Sweden), Ceratium hirundinella, Lake Gorvaln (Sweden), Lappland, Zurich See (Switzerland), Bodensee (Switzerland), Lago di Garda (Italy), Lago di Varese (Italy), Uppland (Sweden), Lago Maggiore (Switzerland and Italy), Lac Leman (Switzerland).

This paper summarizes principal results obtained of primary productivity measurements with the C14 method in Swedish and other European lakes and discusses the problems common to C14 studies in all natural waters--salt and fresh. In all lakes investigated with fractionated C14 filtration, the rule was proven that contribution of nannoplankton algae to primary production exceeds that of net plankton algae. Some C14 experiments with additions of small amounts of phosphate, nitrate, and hypolimnic water, rich in organic compounds, have shown that an increased supply of these substances has a different effect on primary production at various seasons. The primary production within the subsurface layer of optimal light exhibits great regional variations. In addition to the aspects of primary production, the C14 method should permit better insight into utilization and transfer of energy in the metabolism of fresh and marine waters. By means of C14 tracers, efficiency of primary producers and primary consumers is quantitatively measureable, but, for such studies in particular, it is essential to get full evidence of the physiological significance of the C14 uptake, especially its bearing to photosynthesis and respiration (gross and net production). (Jones-Wisconsin)
W70-05669

GEOHYDROLOGIC INTERPRETATIONS OF A VOLCANIC ISLAND FROM ENVIRONMENTAL ISOTOPES,
Geological Survey, Washington, D.C.; Atomic Energy Research Inst., Seoul (South Korea); and International Atomic Energy Agency, Vienna (Austria).
George H. Davis, Chang Kun Lee, Edward Bradley, and B. R. Payne.
Water Resources Research, Vol 6, No 1, p 99-109, February 1970. 11 p, 7 fig, 2 tab, 6 ref.

Descriptors: *Hydrogeology, *Groundwater movement, *Tracers, *Tracking techniques, *Radioactivity techniques, Deuterium, Tritium, Hydrology, Volcanoes, Radiochemical analysis, Aquifers, Geology, Streamflow, Rainfall-runoff relationships, Water resources, Investigations, Surveys.
Identifiers: Korea, Cheju Island.

Isotopic analyses of groundwaters collected from 1966 through 1968 on Cheju Island, Republic of Korea, have proved helpful in interpreting the general hydrologic relations and in developing a model of the groundwater flow system in the permeable volcanic rocks of the island. Comparison of tritium and stable isotope contents provided a basis for a model of the groundwater flow regimes. Time variability of these isotopes determined by repeated samplings provided the basis for estimates of mean residence time of groundwaters, ranging from about 2 to 9 years. Although the results are only approximate because simplified models were used, they can be of substantial assistance in planning further hydrologic investigations and appraising the feasibility of groundwater development. (Knapp-USGS)
W70-05672

REPORT ON SEA WATER DESALINATION ANALYTICAL PROCEDURES,
Beach Test Facility, N.C. Wrightsville.
For primary bibliographic entry see Field 03A.
W70-05714

IRON IN GROUND WATERS OF THE MAGOTHY AND RARITAN FORMATIONS IN CAMDEN AND BURLINGTON COUNTIES, NEW JERSEY,
Geological Survey, Trenton, N.J.
Donald Langmuir.
New Jersey Division of Water Policy and Supply Water Resources Circular No 19, 1969. 49 p, 9 fig, 4 tab, 16 ref, append.

Descriptors: *Water quality, *Groundwater, *New Jersey, *Iron, Withdrawal, Water level fluctuations, Hydrogeology, Data collections, Hydrologic data, Aquifers, Water wells, Water pollution sources, Groundwater movement, Water chemistry.
Identifiers: Camden County (NJ), Burlington County (NJ).

Iron is the major water-quality problem in potable groundwaters of the Magothy and Raritan aquifer system in Camden and Burlington Counties, New Jersey. Most wells tapping the aquifer system in this area yield total iron concentrations in excess of 0.3 mg/liter. The iron is present primarily as dissolved ferrous iron, and as colloidal-sized ferric hydroxide. The water-quality and geohydrologic data suggest that heavy, long-term pumpage in the vicinity of Philadelphia and adjacent parts of New Jersey, has induced the flow of groundwaters up to 7 miles in a northerly direction toward this area since 1900. A reduction in pumpage in the Philadelphia area, coupled with increased pumpage in adjacent New Jersey during the period from 1958 to 1966, has brought about movement of up to 1 mile toward the southeast in Camden County. Adjustment of the groundwater within the aquifer system to marked seasonal changes in pumpage may cause local groundwater movement of up to 1 mile with corresponding changes in iron content. (Knapp-USGS)
W70-05723

2L. Estuaries

WASTE-INDUCED OXYGEN UPTAKE OF AN ALASKAN ESTUARY,
Alaska Univ., College. Dept. of Environmental Health Engineering; and Alaska Univ., College. Inst. of Water Resources.
R. Sage Murphy, and Ann P. Miller.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 94, SA 2, No 5908, p 345-354, 1968. 5 fig, 3 tab, 5 ref.

Descriptors: *Estuaries, *Sewage, Alaska, Biochemical Oxygen Demand, Biodegradation, Waste assimilation capacity, Water purification.
Identifiers: Cook Inlet (Alas), Knik Arm (Alas), Anchorage (Alas).

A study is reported to determine the possible biological effects of sewage discharge generated by Anchorage, Alaska, upon the waters of Knik Arm, a portion of Cook Inlet, to determine optimum disposal method. Large quantities of fine silt and low ambient temperatures of Knik Arm made standard biochemical oxygen demand (BOD) procedure inappropriate as a method for predicting the biological activity of the waters. Natural waters and 2C incubation temperatures were substituted for standard BOD procedure and comparisons with standard BOD values made. At 2C incubation temperature, figures are presented which compare oxygen uptake between waters inoculated with settled sewage, and oxygen consumption by selectively removing sewage or natural water-originating organisms. Considerable oxygen uptake is observed in waters when incubation temperature is 2C. A mixture of sewage and natural water exhibits much greater oxygen consumption than natural water alone. The concentration of silt does not have an appreciable effect upon oxygen consumption. Organisms indigenous to the natural waters have greater effect on decomposition of sewage than sewage-originating organisms. (Haskins-Wisconsin)
W70-05556

FURTHER OBSERVATIONS ON CHANGES IN THE BOTTOM FAUNA OF A FERTILIZED SEA LOCH,
University Coll., Southampton (England).
J. E. G. Raymont.
Journal of the Marine Biological Association of the United Kingdom, Vol 28, p 9-19, 1949. 1 fig, 4 tab, 10 ref.

Descriptors: *Fertilizers, *Sea water, *Bays, Hydrology, Oxygen, Productivity, Nutrients, Sampling, Crustaceans, Phytoplankton, Density, Marine plants, Hydrogen sulfide, Grazing, Fish.
Identifiers: *Bottom fauna, Loch Craiglin (England), Flatfish, Chironomids, Hydrobia ulvae, Cardium, Idothea, Gammarus, Lock Sween, Flounders, Zostera.

Changes in the bottom fauna of a fertilized sea loch during 1944-1947 are compared with those in 1942-1944. The density fell markedly during 1944 despite large fertilizer additions, due to unfavorable hydrographic conditions, especially low oxygen tensions. Highest densities were found in 1945 summer (average of 23,000 animals per square meter) when hydrographic conditions were favorable. High productivity apparently was maintained during 1946, although only little fertilizer was added that year. By 1947 average density of bottom fauna had fallen to only 7500 animals per square meter. This drop may be correlated with less available nutrients, no fertilizers being added after January 1946. Hydrobia ulvae, progressively important from 1944 onward, was the dominant member from 1945. Average dry weight of bottom fauna flesh was 3 grams/square meter in 1942, 9 grams/square meter in summer of 1943, 3.5 grams in 1944, 19.5 grams in 1945, and 7.5 grams in summer of 1947. Constant application of fertilizers during at least two to three years are necessary for maximum production. Even after 2-1/2 years, bottom fauna production was more than twice that of 'natural' conditions. (Jones-Wisconsin)
W70-05569

POTABLE WATER AVAILABILITY ON LONG OCEANIC ISLANDS,
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
Eugene Wallace Rochester, Jr.
Available from the Clearinghouse as PB-191 068, $3.00 in paper copy, $0.65 in microfiche. PhD Thesis, 1970. 66 p, 7 tab, 14 fig, 30 ref, 4 append. OWRR Project No. B-006-NC.

Descriptors: *Islands, *Potable water, *Infiltration, *Saline water, Freshwater interfaces, Saline water intrusion, Interfaces, *Pumping, Induced infiltration, Boundaries (Surfaces), Free surfaces, Flow rates.

Laboratory experiments were conducted to predict maximum safe pumping rates that can be obtained for various soil and rainfall conditions on long oceanic islands. Particular emphasis was given to obtaining potable water on the barrier islands of North Carolina. A Hele-Shaw model was designed and built to represent a cross section of a long oceanic island. The two fluids which simulated fresh water and salt water were obtained by adding a viscosity-increasing agent to water. The density of one batch was increased by adding salt and sugar. The 'fresh water' was added along the top of the fresh-water lens in the model at cyclic time intervals. Fluid was pumped from the fresh-water lens through one of three galleries. Two of the galleries were located below mean sea level, and one was located at mean sea level. During a test, pumping from a gallery was initiated at a low rate and was continued at that rate until equilibrium of the interface was obtained. The pumping rate was increased in increments allowing equilibrium to be reached at each increment until the maximum continuous rate was obtained. Pumping stopped when the free surface was pulled to the top of the gallery or when salt water was pumped into the gallery. Locations of the free surface and interface were recorded for each pumping rate and were presented graphically in dimensionless form. The maximum pumping rate was presented as a function of infiltration and island characteristics. The mathematical boundary conditions and flow equation for the two-dimensional flow problem were also presented.
W70-05646

SOME ASPECTS OF LITTORAL ECOLOGY: THE PARAMETERS OF THE ENVIRONMENT, THEIR MEASUREMENT: COMPETITION, INTERACTION AND PRODUCTIVITY,
Dunstaffnage Marine Research Lab., Oban (Scotland).
Harold Barnes.
American Zoologist, Vol 9, No 2, p 271-277, 1969. 1 fig, 1 tab, 22 ref.

Descriptors: *Littoral, *Ecology, *Environment, *Competition, *Productivity, Algae, Fisheries, Herrings, Zooplankton, Tides, Mathematical models, Diatoms, Basins, Coasts, Statistics, Humidity, Carbon dioxide.
Identifiers: Patella, Aplysia, Balanus balanoides, Nauplii, Entermorpha, Cladophora, Loch Craiglin (Scotland), Lake bottoms, Radiant heat.

The ease of study of littoral ecology is offset by its complexity. Priorities to which aspects of the physical environment are relevant to a given problem should be considered. This complexity, extending to substratum itself, gives possibility of myriads of biotopes for which the more obvious physical parameters are only distantly related to the values of the same parameters as usually measured. The most characteristic feature of the littoral is that it is regularly exposed to air. Problems associated with humidity, radiant heat, or accumulation of carbon dioxide have not been solved. On the shore, plants are primary producers but in direct competition with many animals for space. Attachment to shells is less secure than to rock. This difference plays a distinct part in competition between algae and animals and affects relative distribution in relation to wave action. Problems of mobility of the substratum under wave action become of paramount importance. The flora and fauna may be very different from those on an open coast. Perhaps some of the greatest advances in ecological thought will come from more detailed work in tropical, or at least warm waters. Application of all available techniques, instrumentation and analysis, is necessary. (Jones-Wisconsin)
W70-05649

THE USE OF THE COULTER COUNTER FOR THE DETERMINATION OF MARINE PRIMARY PRODUCTIVITY,
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Lab.
For primary bibliographic entry see Field 07B.
W70-05650

ON THE QUANTITATIVE DISTRIBUTION OF ZOOPLANKTON IN DEEP SCATTERING LAYERS,
Hamburg Univ. (West Germany). Institute fuer Hydrobiologie und Fischereiwissenschaft.
Johannes Kinzer.
Deep-Sea Research, Vol 16, p 117-125, 1969. 6 fig, 28 ref.

Descriptors: *Oceans, *Zooplankton, Biomass, Depth, Copepods, Plankton, Sampling, Diurnal.
Identifiers: *Acoustic scattering layers, *ELAC echo-sounder, Eastern Atlantic Ocean, Arabian Sea, Euphausiids, Deep scattering layers, R V

Meteor cruises, Meteor Bank, Josephine Bank, Canary Islands, Karachi (Pakistan), Bombay (India), Myctophid fish, HAI-20 plankton sampler.

This study was concerned with contribution of zooplankton to the phenomenon of acoustic scattering layers. The plankton samples were collected with closing nets from the deep scattering layer (DSL), as it was recorded by an ELAC echosounder at a frequency of 15 kilocycles/second. In the Eastern Atlantic, the DSL (450-600 meters) had a significantly higher volume and number of organisms than the upper (150-450 meters) and the lower (600-700 meters) layers. The upper zone of the DSL had a somewhat higher density of copepods and euphausiids than other layers. A similar relationship was observed in the Arabian Sea, except that the plankton biomass in the oxygen-deficient part of the DSL was two-thirds less than in its upper part. Up to 90% plankton of Arabian Sea DSL consisted of copepods. Stomach analyses indicated that large populations of myctophid fish in the DSL, particularly Benthosema pterota, feed on copepods. (Wilde-Wisconsin)
W70-05662

FRAGILE ESTUARINE SYSTEMS-ECOLOGICAL CONSIDERATIONS,
Texas Univ., Port Aransas. Inst. of Marine Science.
Donald E. Wohlschlag, and B. J. Copeland.
Water Resources Bulletin, Vol 6, No 1, p 94-105, January-February 1970. 12 p, 3 fig, 32 ref.

Descriptors: *Estuaries, *Ecology, *Aquatic habitats, *Aquatic environment, Aquatic life, Water pollution effects, Estuarine environment.
Identifiers: Estuarine ecology.

Studies of fish species and populations indicate a high degree of fragility for estuarine ecosystems. Slight stresses tend to disrupt energy flow systems and lead to lower levels of biological productivity, shortened food chains and poorer diversity of species. For individual species low-level stresses tend to suppress metabolism and growth processes. Minor stresses can also substantially reduce populations. Stress processes are quantifiable and amenable to mathematical modeling. (Knapp-USGS)
W70-05709

ECOLOGICAL STUDY OF BOLINAS LAGOON, MARIN COUNTY, CALIFORNIA,
Resources and Ecology Projects, Mill Valley, Calif.
Joel F. Gustafson.
In: Proceedings Public Meeting on Water Quality Management for Estuaries, San Francisco, California, February 18-19, 1969, Vol 1, p 168-219, 1969. 52 p, 6 fig, 4 tab, 10 ref.

Descriptors: *Ecology, *Lagoons, *Channels, *Bays, *California, Bottom sediments, Productivity, Ponds, Shallow water, Saline water, Ecological distribution, Biological communities, Ecosystems, Surveys, Aquatic habitats.
Identifiers: Bolinas Lagoon (Calif).

The relationships of bottom sediment types and water chemistry to the distribution of plants and animals in Bolinas Lagoon, California, were studied by making a careful ecological inventory. The consistency of the bottom is as important as the quality of the water in determining the quantity and the variety of life forms living within the bottom material. Sediment particle size measurements and percentages of the total volumes were made for all but one of the stations. Major plant production occurs in shallow flats, both muddy sand and sandy mud, but much less so on sandy flats. Water turbidity and organic richness increase rapidly toward land. The extreme ends of the lagoon are very rich with organic matter, nearly all of which is detritus from marine plants except in and near fresh water marshes. The quantity and variety of life is much higher in muddy sand bottoms than in sandy mud. Use of the muddy sand flats by juvenile fish points out a higher wildlife importance of these areas. There is adequate space within the lagoon for wildlife, recreation and some limited harbor development. (Knapp-USGS)
W70-05713

PHOTOSYNTHETIC BACTERIA ISOLATED FROM THE ARAL SEA,
Akademiya Nauk Kazakhskoi SSR, Alma-Ata. Inst. of Microbiology and Virology; Moscow State Univ. (USSR). Dept. of Soil Biology; and Moscow Univ. (USSR). Dept. of Microbiology.
V. A. Loponitsina, M. I. Novozhilova, and E. N. Kondrat'eva.
Microbiology, Vol 38, No 2, p 299-303, 1969. 1 fig, 2 tab, 11 ref.

Descriptors: *Photosynthetic bacteria, Cultures, Depth, Sulfur bacteria, Chlorophyll, Mud, Hydrogen ion concentration, Oxygen, Salinity, Temperature, Sampling, Spectrometers, Pigments, Chromatography, Colorimetry, Light intensity.
Identifiers: *Aral Sea (USSR), Thiorhodaceae, Athiorhodaceae, Chlorobacteriaceae, Chromatium, Rhodothece, Rhodopseudomonas, Chlorobium limicola, Chloropseudomonas, Carotenoid composition, Physiological properties, Transparency, Rhodospirillium rubrum.

Results of the study of distribution of photosynthetic bacteria in the Aral Sea and determination of their composition and physiological properties is presented. Enrichment cultures of Thiorhodaceae, Athiorhodaceae, and Chlorobacteriaceae, were obtained from the surface layer of different substrates from various depths (4 to 61 meters), though no apparent growth of these microorganisms was observed in the muds. Purple sulfur bacteria were the most widely distributed, being found in 89 out of 99 mud samples. The following strains were obtained in pure cultures and monocultures: Chromatium sp, Rhodothece sp, Rhodopseudomonas sp, Chlorobium limicola, and Chloropseudomonas sp. All investigated strains of purple bacteria contained bacteriochlorophyll a; the green bacteria, bacteriochlorophyll c. Chromatium sp differed from Rhodothece sp in carotenoid composition which evidently caused the coloration difference of their cultures. Bacteria strains studied are close to one another in physiological properties. Cultivation of these bacteria under illumination at 45 to 50,000 lux showed their growth is possible under all conditions, but at light to 500 lux, culture growth occurs more slowly than at 1000 lux and higher. An inhibiting action of high light intensities was not found. (Jones-Wisconsin)
W70-05758

03. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DEVELOPMENT OF SULFONATED POLYPHENYLENE OXIDE MEMBRANES FOR REVERSE OSMOSIS,
General Electric Co., Lynn, Mass.
C. W. Plummer, Gene Kimura, and A. B. La Conti.
Office of Saline Water Research and Development Report No 551, 1970. 73 p. OSW Contract 14-01-0001-2114.

Descriptors: *Desalination, *Reverse osmosis, *Membranes, Membrane processes, Ion-exchange membrane.

Reverse osmosis membranes were prepared by sulfonating 2, 6 - dimethyl polyphenylene oxide. Membrane variables were ion-exchange capacity (2.0 - 3.0 meq. of H+/g of dry polymer), water content (80 - 200% based on dry polymer), and thickness (0.15 - 0.5 mils). The membrane's resistance to compaction and stability at high temperature was demonstrated in a 524 hour life test on synthetic Webster, S. D. water at 130 deg F and 1100 psi. During this test, the product water flux and salt rejection stabilized at 27 gfd and 85%, respectively. (Mintz-Office of Saline Water)
W70-05616

REGENERATION OF ACID WASTES FROM WATER DESALTING EQUIPMENT BY AN ELECTROCHEMICAL METHOD,
Argonne National Lab., Ill.
N. I. Isaev, and M. N. Romanov.
Argonne Lab Trans 788. Available from the Clearinghouse as PB-188 132T, $3.00 in paper copy, $0.65 in microfiche. Izestiya Uchebnykh Zavedenii. Khimiya i Khimicheskaya Tekhnologiya (USSR) v 12 n 7 p 24-928, 1969.

Descriptors: *Industrial wastes, *Electrochemistry, *Desalination, Ion exchange, Chemical engineering.
Identifiers: Hydrochloric acid, Calcium compounds, USSR.

Regeneration of acid wastes from water desalting equipment is carried out because of their subsequent use for regeneration of cation separators. Achieving this in practice permits a reduction in the consumption of concentrated acid entering into the preparation of regenerating solution, and also decreases the use of reagents for waste neutralization. To solve this problem, an electrochemical method is often applied. The relative effectiveness of 3 schemes for electrochemical process conversion of the industrial wastes was studied. It was shown that conditions for conducting the process for the regeneration of wastes, by which the formation of Ca (OH)2 precipitates are excluded, may be controlled by varying the pH of the working solution.
W70-05626

REPORT ON SEA WATER DESALINATION ANALYTICAL PROCEDURES,
Beach Test Facility, N.C. Wrightsville.
John R. Newton, and M. E. Atkins.
Report available for sale from Superintendent of Documents, US Government Printing Office, Wash, DC 20402 - Price $1.25. Office of Saline Water Research and Development Progress Report No 450, May 1969. 133 p, 22 fig, 2 tab, 66 ref.

Descriptors: *Analytical techniques, *Water analysis, *Sea water, *Desalination processes, Methodology, Fresh water, Industrial water, Research and development, Brines, Gravimetric analysis, Instrumentation, Corrosion, Additives.
Identifiers: *Sea water analysis, *Office of Saline Water.

Standard methods used to analyze industrial and fresh waters were not satisfactory for analyzing sea water. The methods were evaluated and modified for use with sea water, brines, and product water at the Office of Saline Water's Wrightsville Beach Test Facility. This report includes colormetric, gravimetric, titrimetric, and instrumental methods of sea water analysis. Interferences which are not common to sea water may be present in samples due to process additives or corrosion of equipment and these interferences must be removed before the actual determination. (Carstea-USGS)
W70-05714

MODIFICATION OF PROTEIN FILMS FOR USE IN WATER DESALINATION,
Harris Research Labs., Inc. Washington, D.C.
Bruce S. Fisher, and Helen Y. Hsiao.
Report available for sale from Superintendent of Documents, US Government Printing Office, Washington, DC 20402 - Price $0.60. Office of Saline Water Research and Development Progress Report No 482, December 1969. 57 p, 8 fig, 17 tab, 30 ref. OSW Contract No 14-01-0001-1811.

Descriptors: *Films, *Proteins, *Desalination processes, *Membrane processes, Permeability,

Osmosis, Membranes, Selectivity, Sodium chloride, Calcium chloride, Sodium sulfate, Brackish water, Research and development.
Identifiers: *Gluten, *Zein, Prolamine, Crosslinked Zein.

The mechanical and permeability properties of zein (the prolamine fraction of corn gluten) membranes were investigated under direct osmosis conditions. Crosslinked zein films at high states of cure had mechanical and permeability properties comparable to other desalination membranes. A 25% improvement in water permeability and 5% increase in the selectivity to sodium chloride were obtained by incorporation of 10-15 wt.% of poly (methacrylamide) in crosslinked zein films. Very high selectivities toward sodium chloride but low intrinsic water permeability were exhibited by films of acetyl zein. The relative permeability of crosslinked zein films to urea, NaCl, Ca chloride, Mg chloride, Na sulfate, Mg sulfate, and sucrose decreased in this order. The data suggest a potential use for zein as a barrier for desalination of high sulfate-content brackish waters. (Carstea-USGS)
W70-05715

RESEARCH ON POROUS GLASS MEMBRANES FOR REVERSE OSMOSIS,
McDonnell Douglas Astronautics Co., Newport Beach, Calif. Western Div.
F. E. Littman, and G. A. Guter.
Report available for sale from Superintendent of Documents, US Government Printing Office, Wash, D C 20402 - Price 60 cents. Office of Saline Water Research and Development Progress Report No 505, 1970. 52 p, 10 fig, 22 tab, 9 ref, 2 append. OSW Contract No 14-01-0001-2110.

Descriptors: *Desalination processes, *Reverse osmosis, Membrane processes, Research and development, Membranes, Ion transport, Semipermeable membranes.
Identifiers: Glass membranes.

The use of 'porous glass' as membrane material for reverse osmosis was investigated in a continuing study. The relationships between manufacturing variables and performance as a reverse osmosis membrane were determined by exploring the effect of composition of the parent glass such as silica content, type of alkali, and other constituents. The conditions of the phase separation were optimized for each composition, and a novel leaching process worked out. The data suggest that useful combinations of salt rejection and flux can be obtained. The major remaining problem is the stabilization of the silica matrix to maintain high performance over long periods of time. Very promising results were obtained in the application of porous glass membranes to life support problems, such as urine and waste water recovery. High quality water was obtained from waste water and the ability of porous glass to handle raw urine without pretreatment was established. (Knapp-USGS)
W70-05890

3B. Water Yield Improvement

MULTIPURPOSE BENEFITS AND COSTS OF MODIFYING PLAYA LAKES OF THE TEXAS HIGH PLAINS,
Texas Technological Coll., Lubbock. Dept. of Agricultural Economics.
Herbert W. Grubb, and Don L. Parks.
International Center for Arid and Semi-arid Land Studies, Special Report Number 6, 66 p, February 1968. 1 fig, 16 tab, 3 append, 25 ref.

Descriptors: *Playas, *Soil texture, *Cost-benefit analysis, *Feasibility studies, *Water storage, Economics, Lake basins, Irrigation water, Mosquitoes, Public health, Texas, Semiarid climates, Runoff, Flood control, Economic feasibility, Costs.
Identifiers: *Playa modification, *Texas High Plains.

Modification of playa lakes in order to concentrate runoff water in deep, small-surface catchments would save water for irrigation use and protect lake-bed cropland from periodic inundation. It would also reduce the water area available for breeding of Culex tarsalis, a mosquito which spreads encephalitis. A study was undertaken to determine the economic feasibility of modifying playa lakes in the fine- and medium-textured soil area of the Texas High Plains. The costs of four different methods of modification were estimated for lakes of 2.5, 8, 15, 25, and 45 acres in both soil areas. Modification benefits were also calculated. Annual net income for each modification type less annual maintenance costs yielded an estimate of annual benefits. Benefits exceed costs for larger lakes (15, 25, and 45 acres) in the fine-textured soils. Modification costs would not be economically feasible for smaller lakes in the fine-textured soils, or for any lake sizes in medium-textured soils. The circular reservoir, Model III, was the modification method yielding the highest net benefits. This study reveals that it would be economically feasible and beneficial to modify 35 percent of the playas found in the Texas High Plains. (Carr-Arizona)
W70-05589

COMPARISON OF CHEMICAL AND NONCHEMICAL TECHNIQUES FOR SUPPRESSING EVAPORATION FROM SMALL RESERVOIRS,
Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering; and Kansas State Univ., Manhattan. Dept. of Agricultural Engineering.
F. R. Crow, and H. L. Manges.
American Society of Agricultural Engineers, Transactions, Vol 10, No 2, p 172-174, March-April 1967. 4 fig, 4 tab, 5 ref.

Descriptors: *Evaporation control, *Evaporation, *Chemcontrol, *Monomolecular films, *Reservoir evaporation, Reservoirs, Water conservation, Baffles, Hexadecanol, Octadecanol, Wind velocity, Evaporation pans, Radiation, Barriers.
Identifiers: *Styrofoam, *Polypropylene mesh, *Small reservoirs.

Most research into the problem of evaporation control has concentrated on chemical methods of evaporation suppression. It is possible that there are non-chemical means which have been overlooked. Experiments are described in which wind baffles, styrofoam, and polypropylene mesh were tested singly and in combination with chemical films to observe their ability to reduce evaporation. Results indicate that a combination of chemical and non-chemical techniques is the most effective method for controlling evaporation on small reservoirs. The best combination appears to be polypropylene mesh and monomolecular film. The mesh not only reduces wind speed at the water surface, but also reflects incoming radiation. (Carr-Arizona)
W70-05606

FOREST LAND USE AND STREAMFLOW IN CENTRAL OREGON,
Forest Service (USDA), Wenatchee, Wash. Pacific Northwest Forest and Range Experiment Station.
H. W. Berndt, and G. W. Swank.
U.S.D.A. Forest Service Research Paper PNW-93, 1970. 15 p, illus.

Descriptors: *Forest management, *Watershed management, *Water yield, *Ponderosa pine trees, Vegetation effects, Lumbering, Small watersheds, Double-mass curves, Reservoir operation, Irrigation water, Grazing, Mining.

A case study was made of land management activities and hydrologic performance of a small, forested basin in central Oregon for the period 1922-65. A significant increase in streamflow, amounting to 2.21 inches, beginning about 1942 was noted. In reviewing land use history, this change in water yield closely coincides with increased timber cutting activity within the basin. Other elements of past and present land use, as well as climatic shifts, are considered. Though sensitive tests of the influence of vegetation on water yield east of the Cascade Range are yet needed, these analyses of existing records provide some insight to the interacting character of forest management activities. (Berndt-USFS)
W70-05618

EFFECTS OF KAOLINITE AS A REFLECTIVE ANTITRANSPIRANT ON LEAF TEMPERATURE, TRANSPIRATION, PHOTOSYNTHESIS, AND WATER-USE EFFICIENCY,
California Univ., Davis.
For primary bibliographic entry see Field 2D.
W70-05635

ECOLOGICAL EFFECTS OF SILVER IODIDE AND OTHER WEATHER MODIFICATION AGENTS: A REVIEW,
Michigan Univ., Ann Arbor, School of Natural Resources.
For primary bibliographic entry see Field 05C.
W70-05671

EVAPOTRANSPIRATION FROM BARE, HERBACEOUS, AND ASPEN PLOTS: A CHECK ON A FORMER STUDY,
Forest Service (USDA), Ogden, Utah. Intermountain Forest and Range Experiment Station.
Robert S. Johnston.
Water Resources Research, Vol 6, No 1, p 324-327, February 1970. 4 p, 1 fig, 2 tab, 5 ref.

Descriptors: *Evapotranspiration control, *Evapotranspiration, *Water yield improvement, *Forest management, *Clear-cutting, Nuclear moisture meters, Soil moisture, Transpiration control.
Identifiers: Neutron moisture measurements.

Soil moisture depletion was measured and evapotranspiration estimated on 3 high elevation plots with 3 cover conditions: bare, herbaceous, and aspen-herbaceous. Neutron moisture measurements were taken to a depth of 9 feet. The 4-year average annual evapotranspiration losses were 11.28, 15.27, and 21.00 inches from the bare, herbaceous, and aspen-herbaceous plots, respectively. Summer rainfall varied from 1.13 to 10.43 inches during this study. The results of this present study substantiate an earlier report concerning the comparative water savings to be realized on the same plots by vegetative manipulation. They show that removing deep rooted aspen can reduce the average evapotranspiration by about 6 inches per year from a 9-foot profile. (Knapp-USGS)
W70-05693

THE FLOW INTERVAL METHOD FOR ANALYZING TIMBER HARVESTING EFFECTS ON STREAMFLOW REGIMEN,
Forest Service (USDA), Parsons, W. Va. Northeastern Forest Experiment Station.
Charles A. Troendle.
Water Resources Research, Vol 6, No 1, p 328-332, February 1970. 5 p, 2 tab, 9 ref.

Descriptors: *Water yield improvement, *Forest management, *Clear-cutting, *Streamflow forecasting, Watershed management, Peak discharge.
Identifiers: Timber harvesting.

A flow interval method of determining the timing of significant portions of annual streamflow was applied to the discharge data from five small mountain watersheds (four treatment watersheds and one control watershed) in West Virginia. Different degrees of timber harvesting had varying effects on the interval lengths and occurrence. The heavier cuttings caused an apparent lengthening in the shortest 25% and 50% intervals. In nearly every instance harvesting resulted in a decrease in the length of the longest 1% and 5% intervals. (Knapp-USGS)
W70-05694

PHYSICAL VIEW OF CLOUD SEEDING,
Department of Commerce, Washington, D.C.; and Federal Council for Science and Technology, Washington, D.C.
Myron Tribus.
Science, Vol 168, No 3928, p 201-211, April 10, 1970. 11 p, 4 fig, 29 ref.

Descriptors: *Cloud seeding, *Cloud physics, *Snow management, *Environmental effects, Rain stimulation, Artificial precipitation, Weather modification, Statistical methods, Hurricanes, Hail, Orography.
Identifiers: *Weather control, Experimental data, Conflict of interests.

Experimental cloud-seeding information is reviewed and the scientific view is particularized to specific applications. The use and misuse of statistics are discussed. Seeding at low temperatures produces many kinds of particles that can act as ice-nucleating agents resulting in overseeded conditions and less rainfall, whereas seeding at higher temperatures produces fewer active nuclei and can increase rainfall. Indiscriminate seeding without knowledge of cloud physics involved can lead to unintended results. Described are topics dealing with lakeshore snow removal, stratus and cumulus clouds related to rain prospects, hail reduction, hurricane modification, and requirements for operational weather modification. Experiences cited show that capabilities for successful cloud seeding now exist in two areas: (1) the increase or decrease of snowpack in some mountains; and (2) the increase of rainfall in some tropical regions. Weather can and will be controlled to the extent that state of the art allows us; we must keep in mind that weather modification means changing the environment, perhaps on a large scale. (Lang-USGS)
W70-05893

THE EFFECT OF ALBEDO-REDUCING MATERIALS ON NET RADIATION AT A SNOW SURFACE,
Forest Service (USDA), Ogden, Utah; Forest Service (USDA), Fort Collins, Colo.; and Colorado State Univ., Fort Collins. Dept. of Watershed Resources.
W. F. Megahan, J. R. Meiman, and B. C. Goodell.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 69-80, March 1970. 12 p, 4 fig, 4 tab, 8 ref.

Descriptors: *Snowmelt, *Albedo, *Water yield improvement, *Snow management, Snowpacks, Water yield, Solar radiation, Melting, Radiation, Snow, Heat budget.
Identifiers: Albedo reduction.

Various albedo-reducing materials were used to increase net radiation at the surface of ripe snow. Increases were evaluated by measuring net radiation on small plots of treated and untreated snow for the period of 1 day. Nine different materials were applied at different weights per unit area for a total of 47 treatments. During short periods of variable incoming radiation, the relation between net radiation on treated and untreated snow was linear. Treatment effects decreased with time for carbon black materials applied at low weights. Net radiation increases averaged for the day were statistically significant in all cases and ranged from 37 to 122% for the various treatments. There was a tendency for the amount of treatment effect to be directly proportional to the weight per unit area of darkening material applied up to a point, above which treatment effects did not increase. Carbon black treatments were more effective than fluid coke and small particles of fluid coke were more effective than large particles. New snow tended to decrease treatment effects, but net radiation was still significantly greater on treated snow as compared to untreated snow, even with up to 4.1 cm of new snow on treated surfaces. (Knapp-USGS)
W70-05903

3C. Use of Water of Impaired Quality

DRIP IRRIGATION - A METHOD USED UNDER ARID AND DESERT CONDITIONS OF HIGH WATER AND SOIL SALINITY,
D. Goldberg, and M. Shmueli.
American Society of Agricultural Engineers, Transactions, Vol 13, No 1, p 38-41, January-February 1970. 10 fig, 3 tab, no ref.

Descriptors: *Irrigation effects, *Irrigation design, *Arid lands, *Saline soils, *Saline water, Salinity, Deserts, Soil texture, Crop production, Irrigation systems, Nozzles, Irrigation water, Irrigation engineering, Irrigation efficiency, Furrow irrigation, Fertilizers, Equipment.
Identifiers: *Drip irrigation, *Israel.

Drip irrigation has many advantages over other forms of irrigation when used in arid regions characterized by saline soil, saline irrigation water, and high evapotranspiration rates. It shortens growing seasons, produces earlier crops, increases crop yield, and makes it possible to grow crops which would normally be salt-damaged. A summary of experimental results is presented which support these conclusions. Also a technical description of the system is included and certain soil problems as they relate to the drip irrigation method are discussed. (Carr-Arizona)
W70-05607

3D. Conservation in Domestic and Municipal Use

MULTIPLE PURPOSE USE OF THERMAL CONDENSER DISCHARGES FROM LARGE NUCLEAR SYSTEMS TO SUPPLEMENT INTER-REGIONAL WATER SUPPLY,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
R. T. Jaske, M. H. Karr, and C. J. Touhill.
67th National Meeting of the AIChE, Atlanta, Paper No. 26E, p 17, February 17, 1970. 2 fig, 3 tab, 7 ref.

Descriptors: *Temperature, *Water supply, *Nuclear power plants, Cooling water, Irrigation, Evaporation, Planning, Thermal capacity.
Identifiers: *Canal-lake system, *Thermal discharge.

The multipurpose use of canal-lake systems as cooling conduits, in conjunction with other uses appears to offer considerable advantage in the redirection of metropolitan growth rates along planned lines. A 1000 MW thermal station requires the passage of from 800 to 1200 cfs of water through the condenser system. The flow of two of these plants would supply the entire water use needs of the cities of Chicago, Los Angeles, or metropolitan New York. A total of 30 GWe, a substantial fraction of the western firm power requirements through the year 2000 could be sited on the canal system. The annual evaporation chargeable to the thermal plant system using the canal-lake complex was 30% lower than the equivalent in direct cooling tower capacity (452,000 AF vs. 650,000 AF) annually. But the total evaporation of the system was considerably larger. A substantially larger canal throughout would not increase the base evaporation levels, and smaller systems optimized for thermal cooling canals would suffer relatively large disadvantages from evaporation unless considered as multipurpose for irrigation, navigation and land development in arid regions. Advantages of the proposed canal-lake system are that nuclear stations can be located far from centers of population. The large transmission system could parallel and reinforce local grids. The canal-lake system provides very large heat dissipative capacity without disturbing environmental esthetics of existing population centers. (Upadhyaya-Vanderbilt)
W70-05784

A NATIONAL ESTIMATE OF PUBLIC AND INDUSTRIAL HEAT REJECTION REQUIREMENTS BY DECADES THROUGH THE YEAR 2000 A.D.,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
For primary bibliographic entry see Field 06B.
W70-05787

WASTE LIQUORS FROM THE MERCERIZATION OF COTTON FABRICS AND LIMITING OF WASTE WATER ALKALINITY (IN CZECH),
For primary bibliographic entry see Field 05D.
W70-05865

3F. Conservation in Agriculture

QUALITY AND SIGNIFICANCE OF IRRIGATION RETURN FLOW,
Washington Univ., Seattle. Dept. of Civil Engineering; and Washington Univ., Seattle. Dept. of General Engineering.
Robert O. Sylvester, and Robert W. Seabloom.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol 89, IR 3, p 1-27, 1963. 9 fig, 6 tab, 29 ref.

Descriptors: *Return flow, *Irrigation effects, *Leaching, Water quality, Ion exchange, Evapotranspiration, Salts, Irrigation water, Water reuse, Drainage effects, Water injury, Analytical techniques, Sewage treatment, Effluents, Irrigation programs.
Identifiers: Yakima River Valley (Wash), Return flow study.

This paper examines evapotranspiration, leaching, ion exchange, erosion, filtration, heat transfer, precipitation of salts and colloids, and biochemical alteration of water and soil constituents and how they alter the quality of water as it passes over or through soil being irrigated. A study technique is outlined to carry out a return flow water quality study to provide data that will permit evaluation of return flow water quality for multi-purpose reuse. Studies should be broad enough to provide data that can be extrapolated to future irrigation projects, and should indicate improvements that may be made in localized areas in regard to water conservation and return water quality. To illustrate the technique, a summary of a study made on the character and significance of irrigation return flow originating from irrigation of a wide variety of crops in the Yakima River Valley in Washington is presented together with a comparison of the impact on Yakima River water quality by irrigation return flows and municipal and industrial waste water discharges. In the lower Yakima River approximately 56% of the river salt content was contributed by irrigation return flows. Leaching was the primary process responsible. (Haskins-Wisconsin)
W70-05563

CHARACTERIZATION OF SOIL AERATION DURING SPRINKLER IRRIGATION,
North Dakota State Univ., Stillwater. Dept. of Agricultural Engineering; Michigan State Univ., East Lansing. Dept. of Agricultural Engineering; and Michigan State Univ., East Lansing. Dept. of Soil Science.
For primary bibliographic entry see Field 02G.
W70-05591

PERFORMANCE CHARACTERISTICS OF SELF-PROPELLED CENTER-PIVOT SPRINKLER IRRIGATION SYSTEMS,
Colorado State Univ., Fort Collins. Dept. of Agricultural Engineering.

D. F. Heermann, and P. R. Hein.
American Society of Agricultural Engineers, Transactions, Vol 11, No 1, January-February 1968. p 11-14, 8 fig, 3 tab, 4 ref.

Descriptors: *Sprinkler irrigation, *Distribution systems, *Rates of application, *Application equipment, Application methods, Irrigation systems, Irrigation practices, Irrigation, Equipment, Sprays, Sprinkling, Equations, Mathematical models, Depth.
Identifiers: *Center-pivot sprinkler irrigation.

Mathematical equations are formulated and solved for application rates and depths on a center pivot sprinkler system. Field measurements are compared with theoretical solutions for distribution of depth from the system. Application rate increases radially outward from the pivot point; application time decreases correspondingly. Necessary formulation is provided for properly designing a self-propelled, center-pivot, sprinkler irrigation system. (Carr-Arizona)
W70-05593

LABORATORY METHOD FOR SUPPLYING MOISTURE UNIFORMLY TO SOIL BY CONDENSATION,
Battelle Memorial Inst., Richland, Wash.; North Dakota Univ., Grand Forks. Dept. of Engineering; Oregon State Univ., Corvallis. Dept. of Mathematics; and Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
D. S. Trent, M. B. Larson, C. Y. Shen, J. E. Postlewaite, and J. W. Wolfe.
American Society of Agricultural Engineers, Transactions, Vol 11, No 4, p 519-522, July-August 1968. 6 fig, 5 ref.

Descriptors: *Soil moisture, *Condensation, *Air circulation, *Thermal conductivity, *Temperature control, Temperature, Flow rates, Irrigation, Plant physiology, Equations, Instrumentation.

The three experimental objectives were: (1) to determine if it were theoretically possible to uniformly condense moisture in a cooled soil test bed from the flow of water-saturated air, (2) to discover a practical means of controlling such moisture deposition, and (3) to decide if the technique were a suitable instrument to aid laboratory research in plant physiology. Theory demonstrates that it is probably impossible, and certainly impractical, to obtain perfect moisture uniformity. However, greatest uniformity can be achieved by minimum variation in temperature. To control this temperature distribution, pins made from material having a higher thermal conductivity than the porous bed are placed in the bed parallel to the flow. The pins, attached to a cooling plate, appear to increase significantly the effective conductivity of the bed. The experiment indicates that optimum uniform moisture deposition is achieved by adjusting the flow rate until the midpoint temperature is within the theoretically allowed variation. (Carr-Arizona)
W70-05594

HYDRAULIC DESCRIPTION OF RECESSION OF SHALLOW FLOW OVER A POROUS BED,
Washington State Univ., Pullman. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 02G.
W70-05596

METHOD FOR DETERMINING MINIMUM-COST FARM-IRRIGATION PIPELINE DESIGN,
Soil Conservation Service, Milford, N.H.
David L. Horn.
American Society of Agricultural Engineers, Transactions, Vol 10, No 2, p 209-212, 216, March-April 1967. 5 fig, 6 ref.

Descriptors: *Irrigation design, *Irrigation engineering, *Costs, *Pipelines, *Pipes, Pipe flow, Concrete pipes, Metal pipes, Plastic pipes, Steel pipes, Conveyance structures, Engineering structures, Structures, Conduits, Design, Equations, Farm equipment, Water loss, Water conservation.
Identifiers: *Conservation irrigation, *Cost functions, Diameter, Head conditions.

A procedure is outlined for determining a combination of border width and pipe diameter to achieve conservation irrigation capability at least cost to the farmer. The procedure is simple, but involves many assumptions. It is possible for the assumptions to be altered without difficulty. The method can be applied not only to concrete pipe, but also to pipelines made from steel, plastic, transite, or other material. Such a rational and systematic approach should eliminate much of the trial-and-error guesswork in pipeline design. (Carr-Arizona)
W70-05597

CONTROL STRUCTURES FOR AUTOMATIC SURFACE IRRIGATION SYSTEMS,
Agricultural Research Service, Kimberly, Idaho. Snake River Research Center; and Idaho Univ., Moscow. Agricultural Experiment Station.
A. S. Humpherys.
American Society of Agricultural Engineers, Transactions, Vol 10, No 1, p 21-23, 27, January-February 1967. 15 fig, 1 ref.

Descriptors: *Automatic control, *Gate control, *Control structures, *Irrigation efficiency, *Surface irrigation, Irrigation, Irrigation systems, Irrigation design, Irrigation engineering, Engineering structures, Check structures, Equipment, Gates, Ditches, Automation, Border irrigation, Furrow irrigation.

Although automated surface irrigation can save water and money for the irrigator, it is not used on a large scale owing to lack of economical equipment and satisfactory design criteria. Various types of automatic control structures are being developed and tested in an effort to satisfy the requirements of different irrigation systems. Structures are needed for lined and unlined ditches in furrow, graded border, basin, furrow cutback, and recirculating systems. The design and testing of automatic flexible check dams for lined and unlined ditches, metal flap gates for unlined ditches, and metal drop gates for lined ditches are discussed. (Carr-Arizona)
W70-05598

CROP YIELD RESPONSE TO NONUNIFORM APPLICATION OF IRRIGATION WATER,
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
Dan Zaslavsky, and Nathan Buras.
American Society of Agricultural Engineers, Transactions, Vol 10, No 2, p 196-198, 200, March-April 1967. 4 fig, 6 ref.

Descriptors: *Application methods, *Crop response, *Irrigation effects, *Irrigation efficiency, *Irrigation water, Water injury, Salinity, Drainage effects, Equations, Variability, Model studies, Mathematical models, Moisture, Aeration, Fluctuation, Crop production.
Identifiers: *Fluctuation response index.

Belief that uniform application of irrigation water is necessary in order to obtain maximum crop yield has led to the use of increasing amounts of water in order to insure uniformity of application. However, surplus moisture may appear in some spots and may be harmful in areas of insufficient drainage, poorly aerated soils, or where there is a salinity problem. An analysis is attempted which would relate degree of treatment uniformity to elicited crop response. The analysis utilizes a 'fluctuation response index' that combines the variability of treatment application with the crop yield response. Assuming that treatment levels in a plot fluctuate symmetrically about the means, average yield Y-bar depends on average treatment level Q-sub-O and a correction factor called the fluctuation response index. (Carr-Arizona)
W70-05604

TRANSFER RESTRICTIONS AND MISALLOCATIONS OF IRRIGATION WATER,
Utah State Univ., Logan. Dept. of Agricultural Economics, and Iowa State Univ., Ames. Dept. of Economics.
B. Delworth Gardner, and Herbert H. Fullerton.
American Journal of Agricultural Economics, Vol 50, No 3, p 556-571, August 1968. 3 fig, 3 tab, 18 ref.

Descriptors: *Water transfer, *Water utilization, *Marginal productivity, *Institutional constraints, *Water allocation (Policy), Utah, Efficiencies, Regression analysis, Value, Prices, Variability, Irrigation water.
Identifiers: *Marginal value product, Covariance analysis, Real price.

Legal rules and institutional policies tend to restrict water use to certain classes of users and types of utilization. It is often argued that inefficiency results from such transfer impediments. Since conditions of unrestricted water movement seldom exist, a case in Utah is important as a study. A Utah area allowed four water companies to exchange water freely after a long period in which only intracompany transfers were permitted. Regression analysis was used to study the increase in the marginal value product of water. Transfer policy and water delivered per irrigated acre were statistically significant variables and accounted for 89 percent of the difference in rental price before and after 1948. Covariance analysis indicated that the real price of water increased by $1.84 in the period since 1948. There is no doubt that this was due to the greater flexibility in transfer. (Carr-Arizona)
W70-05605

COMPARISON OF CHEMICAL AND NONCHEMICAL TECHNIQUES FOR SUPPRESSING EVAPORATION FROM SMALL RESERVOIRS,
Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering; and Kansas State Univ., Manhattan. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 03B.
W70-05606

DRIP IRRIGATION - A METHOD USED UNDER ARID AND DESERT CONDITIONS OF HIGH WATER AND SOIL SALINITY,
For primary bibliographic entry see Field 03C.
W70-05607

EFFICIENT BORDER IRRIGATION DESIGN AND OPERATION,
Agricultural Research Service, Fort Collins, Colo. Northern Plains Branch.
O. W. Howe, and D. F. Heermann.
American Society of Agricultural Engineers, Transactions, Vol 13, No 1, p 126-130, January-February 1970. 10 fig, 5 tab, 6 ref.

Descriptors: *Irrigation design, *Irrigation efficiency, *Irrigation operation and maintenance, *Border irrigation, *Design criteria, Irrigation engineering, Irrigation systems, Uniformity coefficient, Runoff, Soil texture, Slopes, Turnouts, Loam, Infiltration.
Identifiers: *Cutoff time, Stream size, Advance-regression curves.

Experiments were conducted on medium-and fine-textured loam soils in order to study the concept of optimum efficiency resulting from uniform intake opportunity times. The information was used to determine design and operation criteria for minimum runoff and maximum uniformity coefficient. The results indicated that for border irrigation under similar conditions uniformity coefficient is independent of input stream size within the 0.03 to 0.12 cfs per ft of border width range. The coefficient is also independent of slope in the low gradient range and for steeper slopes with close growing crops. 3 to 4 inches during the first 2 hours appears to be the minimum application depth for border irrigation that can be applied with high

uniformity and minimum runoff. High uniformity was easier to obtain on the low gradients. Cutoff time was found to be the most crucial variable for efficient irrigation. Automatic turnout controls would be necessary if adaptation of border irrigation practice is accepted. (Carr-Arizona)
W70-05608

ROTATING-BOOM PLOT IRRIGATOR WITH OFFSET MOUNTING,
Agricultural Research Service, Fort Collins, Colo. Northern Plains Branch; and North Dakota State Univ., Fargo. Agricultural Experiment Station.
J. J. Bond, J. F. Power, and H. M. Olson.
American Society of Agricultural Engineers, Transactions, Vol 13, No 1, p 143-144, 147, January-February 1970. 4 fig, 2 tab, 4 ref.

Descriptors: *Research equipment, *Equipment, *Sprinkler irrigation, *Irrigation design, *Irrigation engineering, Sprinkling, Design, Irrigation systems, Irrigation practices, Irrigation efficiency, Rates of application, Nozzles, Orifices, Application methods, Wind velocity.
Identifiers: *Plots, *Offset mounting, *Rotating boom.

An irrigator specifically designed for sprinkler irrigation research is described and its performance discussed. It is concluded that the field plot irrigator in question has numerous advantages over commercially manufactured systems, among them: (1) On-plot traffic is eliminated by the offset mounting. (2) No disassembly is necessary when moving within the experimental area. (3) Even in relatively high winds, water is applied uniformly with minimum spray drift. (4) Amount of water applied is accurately metered. (5) Rate of application can be varied by changes in operating pressure or nozzle orifices. (6) The system can be adjusted for different crop heights. The only disadvantages of the irrigator appear to be its expense and the circular pattern in which the water is applied. (Carr-Arizona)
W70-05610

SPRINKLER INTENSITY AND SOIL TILTH,
Utah State Univ., Logan. Agricultural and Irrigation Engineering Dept.; and Utah Agricultural Experiment Station, Logan.
For primary bibliographic entry see Field 02G.
W70-05611

A STUDY OF INSTITUTIONAL FACTORS AFFECTING WATER RESOURCE DEVELOPMENT IN THE LOWER RIO GRANDE VALLEY, TEXAS,
Texas A and M Univ., College Station. Water Resources Inst.
For primary bibliographic entry see Field 06B.
W70-05641

SOIL TEMPERATURE PROFILES DURING INFILTRATION AND REDISTRIBUTION OF COOL AND WARM IRRIGATION WATER,
California Univ., Davis.
For primary bibliographic entry see Field 02G.
W70-05688

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on the Surface

GEOMETRIC SHAPING AND CONTOURING OF LAND AS RELATED TO POTENTIAL FOR SURFACE-WATER STORAGE,
Agricultural Research Service, Brookings, S. Dak.; and South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.
C. W. Doty, and J. L. Wiersma.
American Society of Agricultural Engineers, Transactions, Vol 12, No 3, p 332-325, 328, May-June 1969. 8 fig, 3 tab, 12 ref.

Descriptors: *Water storage, *Surface runoff, *Erosion control, *Water conservation, *Soil conservation, Terracing, Contour farming, Runoff, South Dakota, Corn Belt, Shape, Storage capacity, Planting management, Crop production.
Identifiers: *Geometric shaping, *Listing, *8-row bedding.

In the Corn Belt 60-75% of annual runoff and 75-90% of annual erosion occurs during the first 60 days of the corn season (planting to second cultivation). Since it is impossible to apply a crop canopy to the soils, surface configurations on the land are necessary to store water and reduce runoff. The study was designed to discover which of six various geometric shapes had the greatest water-holding capacity. This capacity would determine ability to decrease runoff and erosion. It was concluded that listing and 8-row bedding were the most beneficial configurations, provided they were coupled with very accurate contouring. (Carr-Arizona)
W70-05588

HYDROLOGIC EFFECTS OF FLOODWATER-RETARDING STRUCTURES ON GARZA-LITTLE ELM RESERVOIR, TEXAS,
Geological Survey, Austin, Tex.
For primary bibliographic entry see Field 08A.
W70-05637

PROPERTIES OF TILE DRAINAGE WATER,
Iowa State Univ., Ames.
For primary bibliographic entry see Field 02K.
W70-05642

ORGANIZATION OF DRAINAGE DISTRICTS.

Mo Ann Stat secs 243.080 thru 243.130 (1952).

Descriptors: *Missouri, *Drainage districts, *Ditches, *Legal aspects, Benefits, Drainage, Construction, Assessments, Cost analysis, Cost allocation, Lands, Planning, Maps, Design, Damages, Compensation, Condemantion, Eminent domain, Overflow, Outlets, Legislation, Surveys, Right-of-way.

After the establishment of a drainage district, the county court shall direct the district's engineer, or shall appoint other qualified persons, to file reports determining the location, dimension, and estimated costs of proposed improvements. The report shall contain surveys of the improvements, maps of lands affected, and descriptions of lands necessary to be acquired for rights-of-way. All affected landowners may appear before the viewers and express their opinions concerning the report. Assessment of benefits for improvements shall be limited to those improvements actually constructed. Proper considerations in assessing benefits are outlined. Upon the filing of the report the clerk of the county court shall give notice by publication. The attorney for the drainage district or aggrieved landowners may file exceptions to the report with the county court. The county court has authority to condemn any land needed in connection with the improvements. No district shall enter any lands before compensation is paid to affected landowners. Appeal from county court determinations shall be to the circuit court. The county court has authority to condemn additional land for the district if necessary. (Duss-Florida)
W70-05658

ON THE HIERARCHIAL STRUCTURE OF NATURAL DRAINAGE SYSTEMS,
Hugo E. Mayer, Jr.
Water Resources Research, Vol 6, No 1, p 303-309, February 1970. 7 p, 1 fig, 4 tab, 12 ref.

Descriptors: *Drainage patterns (Geologic), *Tributaries, Drainage density, Geomorphology, Watersheds (Basins), Channel morphology, Geologic control, Streams, Erosion, Mathematical studies, Model studies, Mathematical models.
Identifiers: Bifurcation ratio, Stream length ratio, Basin area ratio, Basin shape.

A relation exists among 4 parameters of natural drainage systems. The parameters are: the bifurcation ratio, the stream length ratio, the basin area ratio, and the stream length ratio raised to a power which is the reciprocal of the basin shape parameter. Bounds for the basin area ratio are determined by exploiting the fact that some streams of order i do not join streams of order $i + 1$ but join streams of higher order. Those bounds, with given values for the basin-shaped parameter, enable us to determine admissible regions for feasible pairs of values that the bifurcation and stream length ratios may assume. A plot of an admissible region and some associated tables are provided. (Knapp-USGS)
W70-05689

A TECHNIQUE OF GENERATING A SYNTHETIC FLOW RECORD TO ESTIMATE THE VARIABILITY OF DEPENDABLE FLOWS FOR A FIXED RESERVOIR CAPACITY,
North Carolina State Univ., Raleigh; and Virginia Polytechnic Inst., Blacksburg.
For primary bibliographic entry see Field 02E.
W70-05692

A TWO-STAGE OPTIMIZATION MODEL FOR DESIGN OF A MULTIPURPOSE RESERVOIR,
California Univ., Los Angeles; and Chile Univ., Santiago.
For primary bibliographic entry see Field 06A.
W70-05700

ROUTE OR CONVOLUTE,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
For primary bibliographic entry see Field 02A.
W70-05702

LAND TREATMENT IN WATERSHED PROGRAM AREAS,
Agricultural Stabilization and Conservation Service, Washington, D.C. Conservation and Land Use Programs Div.
For primary bibliographic entry see Field 04D.
W70-05706

FLOOD PLAIN INFORMATION OF ANDROSCOGGIN RIVER, AUBURN AND LEWISTON, MAINE.
Army Corps of Engineers, Waltham, Mass. New England Div.

Corps Engineers Flood Plain Report, July 1969. 37 p, 8 fig, 8 plate, 4 tab.

Descriptors: *Floods, *Flood damage, *Maine, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood.
Identifiers: Androscoggin River, Auburn (Maine), Lewiston (Maine).

Flooding of the Androscoggin River, Auburn and Lewiston, Maine is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-05716

LEVEE DISTRICTS (USE OF LEVEES AS RAILWAY ROADBEDS).

Mo Ann Stat secs 245.405 thru 245.450 (1959).

Descriptors: *Missouri, *Levees, *Engineering structures, *Railroads, Legal aspects, Legislation, Civil engineering, Land management, Flood protection, Flood control, Administrative agencies, Roadbanks, Embankments, Maintenance, Railroad relocation, Construction, Conservation, Right of way.

Levees may be used as railway roadbeds and railway roadbeds may be used as levees pursuant to contracts between the railroad corporations and the board of directors of levee districts. The duties of a railway company when a levee passes along its roadbed or other embankment are set forth. Whenever a railroad passes over or along land subject to overflow by any river or creek and such land is protected by levees, the railroad has a duty to continue and maintain the levee where it approaches and abuts the railroad right of way. Levee inspectors must see that the crossings of all public and private roads are so constructed that the travel and traffic thereon will not endanger the permanency of the levee or cause a break or crevasse in the levee in time of high water. (Powell-Florida)
W70-05773

DRAINAGE AND LEVEE DISTRICTS: GENERAL PROVISIONS (SUBDRAINAGE AND LEVEE DISTRICTS).
Mo Ann Stat secs 246.010 thru 246.067 (1959).

Descriptors: *Missouri, *Drainage districts, *Levees, *Flood control, Legal aspects, Legislation, Flood protection, Barriers, Administration, Governments, Floods, Overflow, Swamps, Land, Construction, Assessments, Taxes, Cities, Local governments, Water resources development, Administrative agencies, Water control, Abatement.

Owners of lands in main drainage and levee districts may, for the purpose of obtaining and providing local or more complete drainage protection, form and administer subdrainage and levee districts. To secure increased protection, lands in main districts may be united with swamp or overflowed lands, either within or without other districts, in the formation of new districts. Procedures are provided for the cancellation or reduction of assessed benefits to lands in a levee or drainage district where subsequent improvements nullify the benefits accruing from previous improvements. When authorized by the vote of owners of two-thirds of the acreage in any drainage or levee district, that district may issue tax anticipation warrants. (Casey-Florida)
W70-05774

DRAINAGE AND LEVEE DISTRICTS: GENERAL PROVISIONS (OBSTRUCTION, IMPAIRMENT OR DESTRUCTION OF WORKS).
Mo Ann Stat secs 246.180 thru 246.270 (1959).

Descriptors: *Missouri, *Drainage districts, *Levees, *Drainage systems, Legal aspects, Legislation, Dams, Dikes, Flood control, Flood protection, Ditches, Drainage, Bridges, Bridge construction, Drains, Banks, Overflow, Land, Natural resources, Cities, Local governments, Taxes, Assessments, Costs, Watercourses (Legal).

No one may sink, set or drive any supports for bridges in any ditch, drain or watercourse constructed by any drainage or levee district. All supports for bridges must be placed on the banks of ditches, drains, and watercourses so as not to obstruct the flow of water. It is unlawful for anyone to obstruct, impair or destroy any drain, levee, ditch, dike, revetment or other work constructed by any drainage or levee district, and anyone who willfully and maliciously does so, with intent to injure or destroy, is guilty of a felony. Landowners and county sheriffs have the duty to report any violations. Penalties are provided for violation of these provisions. The performance of prescribed duties governing the organization and administration of drainage or levee districts may be enforced by mandamus at the instance of anyone interested in the district. If a municipality consents by adopting an ordinance as prescribed, municipal property situated within or outside the city limits may be included within the boundaries of a drainage or levee district. (Casey-Florida)
W70-05786

KAY-NOOJIN DEVELOPMENT CO V HACKETT (LIABILITY FOR COLLECTION AND DISCHARGE OF SURFACE WATERS).
45 So 2d 792-794 (Ala 1950).

Descriptors: *Alabama, *Surface runoff, *Drainage systems, *Relative rights, Judicial decisions, Ditches, Surface waters, Embankments, Natural flow, Water rights, Rain water, Runoff, Channels, Surface drainage, Legal aspects, Damages.

Plaintiff alleged that defendants, developers of a residential area adjacent to his land, had constructed a drainage system which discharged water onto his land in an unnatural and harmful volume. The trial court overruled a demurrer to the complaint and the Supreme Court of Alabama affirmed. The court stated that an upper proprietor may not collect surface water which would naturally spread out over a wide area and cast it upon the premises of a lower proprietor in unnatural volume, rapidity and channel. (Hubener-Florida)
W70-05833

ELAM V CORTINAS (OBSTRUCTIONS TO DRAINAGE).
53 So 2d 146-149 (La 1951).

Descriptors: *Louisiana, *Drainage, *Relative rights, *Obstruction to flow, Culverts, Bayous, Judicial decisions, Streambeds, Ditches, Drainage programs, Navigable waters, Natural watercourses, Non-navigable waters, Relative rights, Highways, Landfills, Land tenure, Legal aspects, Natural flow.
Identifiers: *Injunctions (Prohibitory), Injunctions (Mandatory).

Plaintiff sued for mandatory and prohibitory injunctions against defendant to prevent interference with drainage from plaintiffs land. Defendant had filled in the bed of a dry bayou which prevented the natural drainage from plaintiff's property from flowing through it. Defendant was also allegedly interfering with the drainage of plaintiff's land in the opposite direction by filling in a culvert. The trial court ordered defendant to cease all interference and to remove the fill in the dry bed of the old bayou. The supreme court held that there was no natural drainage through the old bayou, and consequently defendant did not have to remove the fill. However, the court ordered defendant not to fill in or obstruct any drainage through the culvert. (Hubener-Florida)
W70-05834

MASSEY V BRITT (COVENANT RUNNING WITH PROPERTY TO WITHDRAW WATER FROM A SPRING ENFORCED).

164 SE2d 721-722 (Ga 1968).

Descriptors: *Georgia, *Pipes, *Spring waters, *Judicial decisions, Springs, Water table, Pumping, Running waters, Land tenure, Relative rights, Legal aspects, Water rights.
Identifiers: *Injunctions.

The assignee of a grantee of land sued to enjoin the grantor from interfering with his right to obtain water from a spring located on property retained by grantor. The assignee sought to lay pipe across the grantor's land in order to obtain the water. The Supreme Court of Georgia held that under the deed giving grantee the right to get water from the spring located on grantor's property, grantee need not continue to use a bucket and could install a pipe. However, grantee was limited as to the amount of water which he could remove. (Hubener-Florida)
W70-05836

ROTH V GREAT ATLANTIC AND PACIFIC TEA CO, INC (RELATIVE RIGHTS OF ADJACENT LANDOWNERS).

108 F Supp 390-394 (E D NY 1952).

Descriptors: *New York, *Surface runoff, *Drainage, *Repulsion (Legal aspects), Judicial decisions, Legal aspects, Drainage water, Riddance (Legal aspects), Land reclamation, Drains, Construction, Administrative agencies, Regulation, Permits, Administration, State governments, Public health, Landfills, Social aspects, Area redevelopment, Social needs, Third party effects, Social impact.

Plaintiff landowners brought action to recover damages for alleged negligent flooding of their premises and sought an injunction to restrain the defendant from maintaining the conditions which were alleged to have created the flooding. The basis of the owners' claim was that defendant had provided inadequate drainage facilities in constructing a store, and that water which formerly had run off plaintiffs' land, across defendant's vacant land and into the street, no longer could do so. Plaintiffs' alleged defendant was negligent in not foreseeing the flooding. The court found no negligence, basing its decision on a well-established rule of public policy preferring reclamation and improvement of low lands to the imposition of a perpetual drainage servitude in favor of upper proprietors. Lower landowners, may in good faith and for the purpose of building and improving their land, fill or grade such land even though surface water is cast back on the lands above. (Barnett-Florida)
W70-05845

LEVEE AND DRAINAGE DISTRICTS (HIRING OF ENGINEERS AND WATCHMEN; REPAIR OF IMPROVEMENTS).
Iowa Code Ann secs 455.180-455.183 (1949).

Descriptors: *Iowa, *Drainage districts, *Engineering personnel, *Levees, Drainage programs, Local governments, Legislation, Boundaries (Property), Surface drainage, Surface runoff, Assessments, Swamps, Jurisdiction, Watercourses (Legal), Costs, Repairing, Financing, Legal aspects, Ditches.

The board of a county into which a levee or drainage improvement extends shall employ a competent engineer to inspect such levees or drainage improvements and to report on their condition and need of improvement. The board shall also employ watchmen to watch levees and make necessary repairs on them. This chapter shall be construed to promote proper drainage, leveeing, ditching, and reclamation of swamp and overflow lands. The collection of taxes by the board of a county shall not be impeded on account of irregularities in any proceedings before the establishment of the drainage district. Provision is made for payment of costs. (Hubener-Florida)
W70-05847

CONSOLIDATION OF DISTRICTS, SUBDISTRICTS AND MINOR SUBDISTRICTS.
Ill Ann Stat ch 42, secs 9-1 thru 9-9 (Smith-Hurd 1956), as amended, (Supp 1970).

Descriptors: *Illinois, *Drainage districts, *Local governments, *Drainage systems, Legislation, Judicial decisions, Boundaries (Property), Drainage programs, Regions, Legal aspects, Administration, Assessments, Administrative agencies, Leadership, Political aspects.
Identifiers: *Consolidation.

Any two or more adjoining drainage or levee districts may merge and form a single consolidated district. 'Adjoining' means that the boundaries of the districts are contiguous or overlapping at some point. The county court in the county containing the greater share of the land may approve the merger after an election or a petition signed by a requisite number of adults owning land in the districts. The court must also determine that such a consolidation will be beneficial to the major portion of land in each district. The consolidated district shall succeed to all the records, property, funds, rights and duties of the former districts. Provisions govern the effect of consolidation upon assessments and indebtedness of the merged districts. Upon consolidation the duties of commissioners and other officers of each merged district shall cease and new commissioners appointed. (Hubener-Florida)
W70-05848

HIGHWAY DRAINAGE DISTRICTS.

Iowa Code Ann secs 460.1-460.13 (1949).

Descriptors: *Iowa, *Highways, *Drainage districts, *Local governments, Legislation, Condemnation, Right-of-way, Assessments, Boundaries (Property), Levees, Trees, Orchards, Eminent domain, Ditches, Water control, Flood control, Soil erosion, Drainage programs, Jurisdiction, Legal aspects, Administrative agencies, Costs, Financing.

When it is necessary to drain any part of a highway, a highway drainage district may be established by county boards of supervisors. Such district shall have all the powers granted to drainage and levee districts. Improvements are to be financed out of primary and secondary road maintenance funds and assessments against real estate. The board of supervisors of the county may acquire rights-of-way by condemnation proceedings. Ornamental trees adjacent to dwellings, orchard trees, and trees used as windbreaks may not be destroyed in making the drainage improvements. The right to remove other trees and hedges may be acquired through eminent domain. (Hubener-Florida)
W70-05849

CONVERTING INTRACOUNTY DISTRICTS INTO INTERCOUNTY DISTRICTS (DRAINAGE DISTRICTS).
Iowa Code Ann secs 458.1-458.5 (1949).

Descriptors: *Iowa, *Drainage districts, *Local governments, *Administrative agencies, Legislation, Assessments, Boundaries (Property), Levees, Ditches, Water control, Drainage programs, Jurisdiction, Watercourses (Legal), Surface drainage, Land use, Drainage effects, Flood control, Soil erosion, Legal aspects, Coordination, Land tenure.

When a ditch, drain, or natural watercourse in one county is the common carrying outlet for one or more drainage districts in the other county, the boards of supervisors of the counties may establish intercounty drainage districts. No land may be included in such drainage district unless it receives special benefits from the improvements in the proposed intercounty district. Any affected landowner may appeal the action of the joint boards in establishing the new district to the district court of the county where his land lies. (Hubener-Florida)
W70-05850

LEVEE AND DRAINAGE DISTRICTS (DISTRICTS FORMED BY MUTUAL AGREEMENT OF LANDOWNERS; OUTLETS).
Iowa Code Ann secs 455.151-455.157 (1949), as amended, (Supp 1969).

Descriptors: *Iowa, *Drainage districts, *Levees, *Outlets, Drainage programs, Local governments, Legislation, Eminent domain, Right-of-way, Boundaries (Property), Settling basins, Ditches, Public health, Watercourses (Legal), Surface drainage, Surface runoff, Assessments, Taxes, Jurisdiction, Legal aspects, Drainage systems, Coordination, Administration, Land tenure.

Owners of land lying wholly within one county may provide for the combined drainage of their lands by mutual agreement. Such agreement shall contain a description of the land, the location of drains, settling basins, and ditches to be constructed, the character and extent of the drainage, and the assessment of any damages. The board of supervisors of the county shall carry out the object of the agreement and shall levy taxes against the lands of the drainage district. The board may purchase a right-of-way in an adjoining county to be used as a drainage outlet, and it may exercise the power of eminent domain in the adjoining county. The board may also purchase a right-of-way in an adjoining state. (Hubener-Florida)
W70-05851

LEVEE AND DRAINAGE DISTRICTS.
Iowa Code Ann secs 455.1-455.9 (1949), as amended, (Supp 1969).

Descriptors: *Iowa, *Levees, *Drainage districts, *Ditches, Drainage, Drains, Artificial watercourses, Natural streams, Settling basins, Public health, Agricultural watersheds, Missouri River, River training, Bank protection, Bank erosion, Erosion control, Embankments, Overflow, Bank stabilization, Administrative agencies, Drainage patterns (Geologic), Railroads, Legal aspects, Political aspects.
Identifiers: *Petitions.

The board of supervisors of any county may: establish drainage districts; construct levees, ditches, drains, watercourses, or settling basins; and straighten, widen, deepen, or otherwise change any natural watercourse in such county. The drainage or protection of agricultural lands is presumed to be a public benefit. The word levee is defined to include any construction necessary to protect the banks of any river from wash, cutting, or erosion. All levees, ditches, or drains, so far as practicable and economical, should follow the general course of natural streams or the general course of natural drainage. Whenever any ditch or drain must cross a railroad right-of-way, it should cross at the place of the natural waterway or at such other place as provided by the railroad. Levee or drainage districts may be established upon petition by the owners of 25 percent of the land affected by the proposed district. If the proposed district involves only the straightening of a stream, 35 percent of the above-mentioned owners must petition using the prescribed form for a petition. (Dearing-Florida)
W70-05852

DRAINAGE DENSITY IN DRIFT-COVERED BASINS,
Washington State Univ., Pullman. Dept. of Engineering.
For primary bibliographic entry see Field 2E.
W70-05884

4B. Groundwater Management

NITRATE ACCUMULATION IN KANSAS GROUNDWATER,
Kansas Water Resources Research Inst., Manhattan.
For primary bibliographic entry see Field 05B.
W70-05644

PRELIMINARY RESULTS OF HYDROLOGIC STUDIES AT TWO RECHARGE BASINS ON LONG ISLAND, NEW YORK,
Geological Survey, Washington, D.C.
G. E. Seaburn.
Geological Survey Professional Paper 627-C, p C1-C17, 1970. 17 p, 15 fig, 4 tab, 13 ref, append.

Descriptors: *Pit recharge, *Storm runoff, *Cities, *New York, Artificial recharge, Water table, Infiltration, Permeability, Water management (Applied), Water reuse, Urbanization, Hydrographs.
Identifiers: Long Island (NY).

More than 2,000 recharge basins on Long Island are used to dispose of storm runoff from residential and industrial areas and highways. Two of these basins have been instrumented to measure the response time of runoff generated from a rainfall event and to study inflow patterns and the infiltration rates of the selected basins. The time lag recorded at the Westbury test basin from the start of rainfall to the start of inflow ranged from 5 to 20 minutes. The time lag from the start of rainfall to the initial rise in the water table was between 2 and 8 hours. The average ratio of storm-water inflow to rainfall closely approximates the ratio of paved street area to total drainage area of both basins. The estimated average annual volume of groundwater recharge in 1967 was 7.5 acre-feet for the Westbury recharge basin and 10 acre-feet for the Syosset recharge basin. The average infiltration rate at the Westbury recharge basin for 12 storms during the summer and fall of 1967 was 211 gallons per day per square foot. (Knapp-USGS)
W70-05711

THE METHODS OF STUDYING THE FREE UNCONFINED GROUNDWATER REGIME IN IRRIGATION REGIONS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
D. M. Katz.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 262-268, 1968. 7 p, 2 tab, 3 ref.

Descriptors: *Irrigated land, *Observation wells, *Groundwater recharge, *Methodology, Network design, Regional analysis, Water balance, Salt balance, Aeration, Evaporation, Transpiration, Precipitation (Atmospheric), Convection, Diffusion.
Identifiers: *USSR, Groundwater salinity.

In the USSR, three types of observation networks are used to solve groundwater problems. These types are: regional network, network within a farming area, and special temporary network. Knowledge of the water and salt balance are necessary to quantitatively estimate the groundwater recharge and discharge as well as groundwater salinity. The hydrochemical regime of groundwater is a result of the following process: (1) Enrichment with salts which are leached from the zone of aeration; (2) concentration of salts by evaporation and transpiration; (3) precipitation of salts as a result of change in concentration and other processes; (4) convective and molecular diffusion and exchange reactions. (Carstea-USGS)
W70-05731

METHODS OF STUDY OF THE GROUNDWATER BUDGET IN NORTH AMERICA,
For primary bibliographic entry see Field 02F.
W70-05733

GEOLOGY, HYDROLOGY, AND QUALITY OF WATER IN THE HANFORD-VISALIA AREA, SAN JOAQUIN VALLEY, CALIFORNIA,
Geological Survey, Menlo Park, Calif.
For primary bibliographic entry see Field 02F.
W70-05737

INJECTION OF RECLAIMED WASTEWATER INTO CONFINED AQUIFERS,
Toups Engineering, Inc., Santa Ana, Calif.; and Orange County Water District, Santa Ana, Calif.
For primary bibliographic entry see Field 05D.
W70-05880

4C. Effects on Water of Man's Non-Water Activities

URBAN STORM RUNOFF RELATIONS,
Nebraska Univ., Lincoln; Public Health Service, Denver, Colo.; and Maine Univ., Orono.
Warren Viessman, Jr., Walter R. Keating, and Kalkunte N. Srinivasa.
Water Resources Research, Vol 6, No 1, p 275-279, February 1970. 5 p, 3 fig, 1 tab, 7 ref.

Descriptors: *Storm runoff, *Rainfall-runoff relationships, *Cities, *Peak discharge, *Mathematical models, Water storage, Infiltration, Routing, Unit hydrographs, Hydrograph analysis, Computer programs, Runoff forecasting.
Identifiers: Urban hydrology.

A model incorporating the hydrologic and hydraulic phases of storm water flows to estimate the runoff from a 23-acre residential area has prediction errors that are generally less than 10% when the peak flow is used as the criterion for comparison. The runoff process of the Gray Haven area, Baltimore is simulated by a linear reservoir, linear channel model. A sequence of 1-minute effective rainfall intensities serves as the input. The effective precipitation is computed directly from the gaged storm pattern by applying one of the loss functions. Depression storage and infiltration are considered to be the primary loss components of the Gray Haven area. The findings point out that a separate consideration of pervious and impervious surfaces in runoff computations for relatively small urban areas might be important. (Knapp-USGS)
W70-05684

PRELIMINARY RESULTS OF HYDROLOGIC STUDIES AT TWO RECHARGE BASINS ON LONG ISLAND, NEW YORK,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 04B.
W70-05711

EFFECTS OF URBAN DEVELOPMENT ON DIRECT RUNOFF TO EAST MEADOW BROOK, NASSAU COUNTY, LONG ISLAND, NEW YORK,
Geological Survey, Washington, D.C.
G. E. Seaburn.
Geological Survey Professional Paper 627-B, p B1-B14, 1970. 14 p, 5 fig, 1 plate, 8 tab, 18 ref.

Descriptors: *Rainfall-runoff relationships, *New York, *Urbanization, *Storm runoff, Storm drains, Unit hydrographs, Duration curves, Hydrographs, Hydrology.
Identifiers: Nassau County (NY), Long Island (NY), Urban hydrology.

The effects of intensive urban development on direct runoff to East Meadow Brook, a southward-flowing stream in central Nassau County, N. Y., during the period 1937-66, are described. The special objectives of the study were to relate indices of urban development to increases in the volume of annual direct runoff to the stream; to compare hydrograph features at different periods during the transition of the drainage basin from rural to urban conditions; and to compare the rainfall-runoff relations for periods before and after urban development. Periods of housing and street construction in the drainage basin correspond to 3 distinct periods of increased direct runoff. During each period, the average annual direct runoff increased because of an increase in the area served by storm sewers that discharged into East Meadow Brook. The amount of land served by sewers increased from about 570 acres in 1943 to about 3,600 acres in 1962, or about 530 percent. During this same period, the average annual direct runoff increased from about 920 acre-feet per year to about 3,400 acre-feet per year, or about 270 percent. (Knapp-USGS)
W70-05712

UTILIZATION OF MARGINAL LANDS FOR URBAN DEVELOPMENT,
Partner, Mueser, Rutledge, Wentworth and Johnston, New York.
For primary bibliographic entry see Field 08D.
W70-05881

REAL-TIME COMPUTER CONTROL OF URBAN RUNOFF,
Minneapolis-St. Paul Sanitary District, St. Paul, Minn.
For primary bibliographic entry see Field 07C.
W70-05882

4D. Watershed Protection

LAND TREATMENT IN WATERSHED PROGRAM AREAS,
Agricultural Stabilization and Conservation Service, Washington, D.C. Conservation and Land Use Programs Div.
Earnest L. Gambell.
Water Resources Bulletin, Vol 6, No 1, p 15-22, January-February 1970. 8 p, 2 tab, 3 ref.

Descriptors: *Land management, *Watershed management, *Small watersheds, Planning, Cultivated lands, Erosion control, Farm ponds, Flood control, Soil management, Water conservation, Water management (Applied).
Identifiers: *Watershed planning.

Several types of watershed program areas, principally but not solely those operated under authority of the Watershed Protection and Flood Prevention Act, are greatly altering the American landscape. While structural measures tend to be the most visible feature of these watersheds, land treatment measures (soil, water, woodland, and wildlife conservation practices) are basic to the long term stability and maximum contributions of these watershed programs. Under the land use and management policies of this country, the farm owners and operators in these watersheds have the primary responsibility for land treatment and conservation. In practice, farmer interest and action are largely stimulated and sustained as a result of the operation of functional leaders of farmer-public conservation partnership programs. Examples include locally elected agricultural stabilization and conservation committees, soil and water conservation district supervisors, and watershed program sponsors. (Knapp-USGS)
W70-05706

CONSERVATION--SOIL AND WATER--DEFINITIONS, SUBDISTRICTS.

Mo Ann Stat secs 278.070 thru 278.290 (Legis Service No 2 1969).

Descriptors: *Missouri, *Water conservation, *Administrative agencies, *Water districts, Administration, Water law, Water management, Water policy, Water supply, Governments, Legal aspects, Administrative decisions, Legislation, Local governments, State governments, Institutions, Water conservation, Planning, Political aspects, Leadership, Taxes, Cities, Coordination, Federal government.

Subdistricts of soil and water conservation districts may be formed on petition of the landowners of such districts. Land already in one subdistrict may not be included within another. Soil and water commissioners shall determine whether operation of a subdistrict is feasible and submit the question to landowners for referendum. The board of soil and water conservation supervisors of the district within which the subdistrict is formed shall govern the subdistrict. Three persons within the subdistrict shall be elected its trustees by a majority of the landowners participating in the referendum. The trustees shall: (1) act as an executive committee for the subdistrict; (2) recommend tax levies to the governing body; (3) secure land rights; and (4) arrange for inspection and maintenance of completed works or improvements. After a subdistrict has existed for five years without constructing works or improvements, landowners by referendum may disestablish the subdistrict. Two or more subdistricts may be consolidated on vote of landowners. Water conservation units may, as provided herein, cooperate with the federal government. The terms board of soil and water district supervisors, land representative, conservation district, soil and water districts commission, township, and landowner are defined. (Dye-Florida)
W70-05885

05. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification of Pollutants

FREE AMINO ACIDS AND RELATED SUBSTANCES IN MARINE ORGANISMS,
City of Hope Medical Center, Duarte, Calif.
For primary bibliographic entry see Field 05C.
W70-05631

QUANTITATIVE MICRO-DETERMINATION OF LIPID CARBON IN MICROORGANISMS,
California Univ., San Diego, La Jolla. Inst. of Marine Resources; and Scripps Institution of Oceanography, La Jolla, Calif. Div. of Marine Biology.
For primary bibliographic entry see Field 07B.
W70-05651

BIOASSAY OF SEAWATER. IV. THE DETERMINATION OF DISSOLVED BIOTIN IN SEAWATER USING C-14 UPTAKE BY CELLS OF AMPHIDINIUM CARTERI,
California Univ., San Diego, La Jolla. Inst. of Marine Resources.
A. F. Carlucci, and S. B. Silbernagel.
Canadian Journal of Microbiology, Vol 3, p 979-986, 1967. 2 fig, 3 tab, 11 ref.

Descriptors: *Bioassay, *Sea water, *Vitamins, Vitamin B, Algae, Cultures, Chemical analysis, Analytical techniques, Dinoflagellates, Marine bacteria, Water chemistry, Carbon radioisotopes, Pacific Ocean, Carbon dioxide, Light, Temperature.
Identifiers: *Biotin, *Amphidinium carteri, *Radiocarbon uptake techniques, Water pollution identification, Organic solutes, Vitamin B-1, Vitamin B-12, Thiamine, Serratia marinorubra, Gyrodinium cohnii, Microbial ecology, Coulter counter, Growth inhibition, Cyanocobalamin, Mutant bacteria, Cyclotella nana, Geiger counter.

Three vitamins of potential importance in marine microbial ecology are biotin, cyanocobalamin (B-12), and thiamine (B-1). Mutant marine bacteria and heterotrophic dinoflagellates have been employed in bioassays to estimate biotin previously, but such assays have been relatively insensitive. Biotin dissolved in seawater can be determined by rapid, sensitive, and precise technique described. Uptake of radiocarbon-labeled carbon dioxide cells of the marine dinoflagellate, Amphidinium carteri, during 2 hours following 94 hours of preincubation under carefully controlled conditions is proportional to biotin concentration. Cells can be enumerated in hemacytometer or with electronic particle counter to evaluate growth responses of dinoflagellate populations to vitamin concentrations, but incubation must be extended to 144 or 168 hours to obtain proportional dose-response curves. Biotin can be assayed in range of concentrations, 0.2-6.0 nanograms/liter, a sensitivity considerably greater than those for microbiological assays previously described. Six replicated determinations at 1 and 3 nanograms/liter yielded standard deviations of 0.09 and 0.28 respectivly. From the north Pacific Ocean, 45 samples contained biotin in concentration range, 0.65-3.0 nano-

grams/liter. Availability of techniques for assay of ecologically important concentrations of vitamins makes possible a study of their role in marine environments. (Eichhorn-Wisconsin)
W70-05652

INFLUENCE OF METHOD FOR REMOVAL OF SESTON ON THE DISSOLVED ORGANIC MATTER. II. COBALAMINS,
Washington Univ., St Louis, Mo. Dept. of Botany.
For primary bibliographic entry see Field 07B.
W70-05656

MICROBIOLOGICAL ANALYSIS OF WATER.
Millipore Corp., Bedford, Mass.

Millipore Corporation Application Report AR-81, 1969. 25 p, 37 fig, 5 ref.

Descriptors: *Water analysis, *Filtration, *Membrane processes, Coliforms, Aquatic microbiology, Aquatic microorganisms, Water quality, Enteric bacteria, Pathogenic bacteria, Sewage bacteria, Iron bacteria.
Identifiers: Membrane filters.

Membrane filter methods for microbial analysis of water samples are described. The use of membrane filters for isolating and identifying coliform and other bacterial organisms is now well established. In many state and federal laboratories it is the preferred method owing to its simplicity, sensitivity and the fact that the MPN method requires about four times as long. In many cases, the membrane filter method has made it possible to substitute field testing for laboratory analysis. Investigators have used it to isolate pathogenic bacteria for identification purposes when outbreaks of enteric illness were traced to water supply. Detailed in this application report are a variety of specific techniques for isolating and identifying bacterial organisms in raw and treated water, swimming pools, treated sewage and industrial process, rinse and cooling water. (Knapp-USGS)
W70-05722

AN AUTOMATED SYSTEM FOR THE DETERMINATION OF CHEMICAL OXYGEN DEMAND,
Upper Tame Main Drainage Authority, Birmingham (England).
A. E. Hey, A. Green, and N. Harkness.
Water Research, Vol 3, p 873-886, 1969. 4 fig, 5 tab, 6 ref.

Descriptors: *Chemical oxygen demand, *Measurement, *Sewage effluents, Analytical techniques, Automation, Colorimetry, Instrumentation.
Identifiers: Dichromate reduction, Automated apparatus.

Although equipment for automated determination of chemical oxygen demand (COD) is now commercially available, it is not suitable for a continuous analysis of effluents. The described procedure comprises metering of volume samples digested with mercuric sulfate, potassium dichromate, and sulfuric acid in mixture pots. The solution is pumped through a 40 foot glass coil suspended in a fluidized sand bath heated to 160C. The cooled solution is passed through a colorimeter which records the reduction of dichromate. The COD is computed by reference to the peak heights given by standards. The modification of the method eliminates the peristaltic pump, an item responsible for frequent breakdown of the assembly. (Wilde-Wisconsin)
W70-05762

THE REAL NATURE OF THE STREETER-PHELPS TEMPERATURE COEFFICIENT,
Washington Univ., Seattle.
Arthur A. Benedict, and Dale H. Carlson.
Water and Sewage Works, Vol 117, No 2, p54-57, February 1970. 2 fig, 2 tab, 5 ref.

Descriptors: *Self-purification, *Temperature effects, *Thermal properties, Biodegradation, Biochemical oxygen demand, Water pollution, Water properties, Energy conversion, Sewage treatment, Waste assimilative capacity.
Identifiers: Streeter-Phelps thermal coefficients.

Comparison of van't Hoff temperature relationship for the temperature reaction rate constant with the Streeter-Phelps temperature coefficient was done with the following conclusions: The temperature coefficient theta associated with the Streeter-Phelps equation can be interpreted in terms of theoretical van't Hoff relationship. However, calculations based on the van't Hoff expression show that theta is a decreasing function of temperature. If a value independent of temperature is applied, the error connected with this assumption for most engineering work is less than 10%. In cases where precise results can be readily obtained, this error may not be acceptable and the approximate nature of the Streeter-Phelps equation should be recognized, and the applicability of this formulation should be tested using the fundamental van't Hoff equation as a base. (Novotny-Vanderbilt)
W70-05782

NEW CORRELATIONS AND TABLES OF THE COEFFICIENT OF VISCOSITY OF WATER AND STEAM UP TO 1000 BAR AND 1000 DEG C,
Glasgow Univ. (Scotland).
For primary bibliographic entry see Field 07C.
W70-05783

TREATMENT OF TEXTILE WASTE LIQUORS,
For primary bibliographic entry see Field 05D.
W70-05863

COMPARISON OF DETERMINATION OF ORGANIC COMPOUNDS IN RETTING WASTE WATERS BY CHEMICAL AND BIOCHEMICAL OXYGEN DEMAND METHODS (IN POLISH),
Jacek Mackowiak.
Instytut Wlokien Lykowych, Prace Vol. 12, p 141-152 1965.

Descriptors: *Chemical oxygen demand, *Biochemical oxygen demand, *Dichromate, *Analytical techniques, Test procedures.
Identifiers: *Flax retting wastes.

In order to find the most appropriate method for determining the COD of flax retting waste waters and its correlation with BOD as determined by the dilution method, experiments were carried out on determination of COD of pure compounds contained in the waste waters and of the waste water themselves. Among chemical methods, the dichromate standard method involving Ag2SO4 as catalyst gave most satisfactory results. Statistical treatment of results led to a correlation formula between BOD and COD in the form: $y = 0.6386x$, where y is BOD in mg. 0/l and x is COD in mg. 0/l. C (1-) ions in concentrations found in flax retting waste waters have no influence on the determination of COD by the standard dichromate method. (Livengood and Mattox-North Carolina State University)
W70-05873

TREATMENT OF WASTE WATERS FROM THE WOOL INDUSTRY (IN RUSSIAN),
For primary bibliographic entry see Field 5D.
W70-05875

5B. Sources of Pollution

QUALITY AND SIGNIFICANCE OF IRRIGATION RETURN FLOW,
Washington Univ., Seattle. Dept. of Civil Engineering; and Washington Univ., Seattle. Dept. of General Engineering.
For primary bibliographic entry see Field 03F.
W70-05563

MINE WATER RESEARCH: CATALIC OXIDATION OF FERROUS IRON IN ACID MINE WATER BY ACTIVATED CARBON,
Bureau of Mines, Washington, D.C.
Edward A. Mihok.
Available from the Clearinghouse as PB-188 645, $3.00 in paper copy, $0.65 in microfiche. Report of investigations, RI-7337, December, 1969. 11 p.

Descriptors: *Acid mine water, Mine drainage, Mine wastes, *Water pollution sources, *Mining engineering, Oxidation, Acids, Catalysts, Carbon.
Identifiers: *Activated carbon treatment, Water treatment.

Laboratory batch-flow tests conducted on a highly ferruginous acid mine water with an activated carbon showed that ferrous iron is rapidly oxidized. This indicates that air oxidation of ferruginous acid in mine waters is catalyzed by activated carbon. The ferrous iron content of an acid mine water flowing through an aspirated activated carbon column was reduced from about 700 to about 10 parts per million in less than 1 minute. Highly efficient ferrous iron oxidation was achieved by conditioning the activated carbon by repeated treatment with acid mine water and air. The reaction proceeds rapidly in the acid environment (pH about 2.5) engendered by ferrous iron oxidation. The activated carbon was used repeatedly with little loss in efficiency, no discoloration, or solids deposition. In these batch tests, about one-third of the iron was adsorbed by the carbon, but with continuous flow, little iron adsorption is expected. Incorporating a catalytic oxidation step in the treatment of acid mine waters containing ferrous iron would greatly facilitate neutralization--precise control of pH, lower reagent costs, elimination of aeration equipment, and smaller holding ponds.
W70-05623

NITRATE ACCUMULATION IN KANSAS GROUNDWATER,
Kansas Water Resources Research Inst., Manhattan.
Larry S. Murphy, and Jay W. Gosch.
Available from the Clearinghouse as PB-191 066, $3.00 in paper copy, $0.65 in microfiche. Project Completion Report, March 1970. 56 p, 13 tab, 19 fig, 38 ref. OWRR Project A-016-KAN.

Descriptors: *Nitrates, *Groundwater, Fertilization, Irrigation, Nitrogen, Farm wastes, Fertilizers, Ammonium compounds, Water pollution sources.
Identifiers: *Nitrate movement, Feedlots.

A study of nitrate-nitrogen accumulation in soils underlying feedlots in Kansas revealed accumulations of as high as 5000 kg/ha in a 4 meter soil profile. Age of the feedlots was found to be directly related to the amount of nitrate-nitrogen which had accumulated in the soil. Vertical movement of nitrate-nitrogen in feedlot soils had occurred even in areas of low rainfall (40-45 cm per annum). Large accumulations of ammonium-nitrogen but no nitrate-nitrogen were noted in a feedlot soil with a very low cation exchange capacity. Analyses of groundwater at that location were inconclusive in relating lack of nitrate-nitrogen in the soil profile with higher levels of nitrate-nitrogen in shallow aquifers. An investigation of the effects of high rates of applied inorganic nitrogen on nitrate-nitrogen accumulations in soil and groundwater was conducted azt two locations. Downward movement of nitrate-nitrogen under irrigated conditions was detected by deep soil sampling (5-6 meters) and comparisons of nitrate-nitrogen concentration peaks in the soil profile. Much variation in the amount of nitrate-nitrogen in the soil profile was noted even with uniform rates of nitrogen application. Investigation of nitrate-nitrogen accumulation in groundwater by means of check wells in the areas receiving large amounts of inorganic nitrogen revealed large fluctuations in the nitrate-nitrogen content over the life of the study but did not produce indications of definite trends. (McKenna-Kansas)
W70-05644

TRITIUM RAINOUT IN THE UNITED STATES DURING 1966, 1967, AND 1968,
Massachusetts Univ., Amherst; and Geological Survey, Washington, D.C.
G. L. Stewart, and T. A. Wyerman.
Water Resources Research, Vol 6, No 1, p 77-87, February 1970. 11 p, 4 fig, 5 tab, 7 ref.

Descriptors: *Fallout, *Rainfall, *Tritium, *United States, Nuclear explosions, Precipitation (Atmospheric), Hydrologic cycle, Hydrologic budget, Tracers, Tracking techniques, Data collections, Radioactivity techniques, Tagging, Surveys.
Identifiers: Tritium rainout.

Annual weighted average tritium concentration and total tritium rainout for United States precipitation continued to decline during 1966 1967, and 1968. Arithmetic mean weighted average tritium concentration for 12 network stations decreased about 38% in 1966 compared to 1965; about 35% in 1967 compared to 1966; and about 30% in 1968 compared to 1967. The 1966, 1967, and 1968 values were only 20%, 13%, and 9% respectively, as great as they were in 1963. Tritium data for special samples collected following the Chinese nuclear bomb test on May 9, 1966, and June 17, 1967, indicate that no measureable tritium was added to United States precipitation as a result of these nuclear explosions. Tritium data are presented in both tabular form and on contoured United States maps in order that estimates of the tritium input function from precipitation to hydrologic systems can easily be made. (Knapp-USGS)
W70-05670

ACCUMULATION OF RADIONUCLIDES IN BED SEDIMENTS OF THE COLUMBIA RIVER BETWEEN THE HANFORD REACTORS AND McNARY DAM,
Battelle Memorial Inst., Richland, Wash., and Geological Survey. Portland, Oreg.
Jack L. Nelson, and W. L. Haushild.
Water Resources Research, Vol 6, No 1, p 130-137, February 1970. 8 p, 6 fig, 2 tab, 12 ref. Contract AT (45-1)-1830 AEC.

Descriptors: *Radioisotopes, *Bottom sediments, *Columbia River, *Washington, *Path of pollutants, Sediment transport, Adsorption, Particle size, Particle shape, Deposition (Sediments), Sediment discharge, Sediment load, Tracers, Tracking techniques.
Identifiers: Hanford (Wash), Pasco (Wash).

Amounts of radionuclides from the Hanford reactors contained in bed sediments of the Columbia River were estimated by two methods: (1) from data on radionuclide concentration for the bed sediments between the reactors and McNary Dam, and (2) from data on radionuclide discharge for river stations at Pasco, Washington, and Umatilla, Oregon. Umatilla is 3.2 kilometers below McNary Dam. Accumulations of radionuclides in the Pasco to Umatilla reach estimated by the 2 methods agree within about 8%. In October 1965 approximately 16,000 curies of gamma emitting radionuclides were resident in bed sediments of the river between the Hanford reactors and McNary Dam. Concentrations and accumulations of chromium-51, zinc-65, cobalt-60, manganese-54, and scandium-46 generally are much higher near McNary Dam than they are in the vicinity of the reactors. These changes are caused by an increase downstream from the reactors in the proportion of the bed sediment that is fine-grained and the proportions of the transported zinc, cobalt, manganese, and scandium radionuclides associated with sediment particles. (Knapp-USGS)
W70-05675

SEDIMENT IN RELATION TO WATER QUALITY,
Agricultural Research Service, Oxford, Miss. Sedimentation Lab.
E. H. Grissinger, and L. L. McDowell.
Water Resources Bulletin, Vol 6, No 1, p 7-14, January-February 1970. 8 p, 45 ref.

Descriptors: *Water quality, *Sediments, *Water chemistry, *Path of pollutants, Ion exchange, Clay minerals, Particle size, Suspended load, Turbidity, Sediment yield, Sediment load, Erosion, Colloids, Sorption, Sediment transport, Diffusion, Mass transfer.
Identifiers: *Sediment-water quality relations.

The relation between sediment and water quality involves the individual relations between sediment and the physical, chemical, and biological characteristics of water as these characteristics determine the suitability of water for an intended use. Both the physical and chemical properties of fine-grained sediments must be considered in evaluating these relations, whereas only the physical properties of coarse-grained sediments are significant. Most of the literature concerning this subject has considered sediment only as a physical entity. In amount, it is the prime pollutant and is one of the major considerations in evaluating the suitability of water for an intended use. Losses in the United States from sediment and associated flood water damages are measured in billions of dollars annually. Sediments also indirectly affect water suitability through their physical influences on biological activity. Fine-grained sediments, that is, clay minerals and amorphous and organic materials, have chemically active surfaces. These sediments may either sorb ions from solution or release ions to solution depending upon the chemical environment. The ternary system--sediment-water-dissolved chemical load--was studied to define its influence on the biological characteristics of water and the suitability of water for various long-term uses. (Knapp-USGS)
W70-05705

WOOL PROCESSING AND STREAM POLLUTION,
J. W. Masselli, N. W. Masselli, and M. G. Burford.
Textile Industries, Vol. 125, p 121, 128, 132, 137, and 142-144, 1961.

Descriptors: *Water pollution, Detergents, Soaps.
Identifiers: *Wool scouring wastes, *Solvent recovery, *Chemical substitution, Wool, Wool grease, Suint, Carding oil, Acetic acid, Sulfuric acid, Ammonium sulfate.

It is shown that natural impurities extracted from the wool (wool grease and suint), soap, carding oils and acetic acid produce practically all of the BOD from the wool industry. The natural impurities may be removed through solvent recovery and soap may be replaced by low BOD detergent or sulfuric acid. Acetic acid may be replaced by ammonium sulfate and low-BOD carding oils may replace the high-BOD oils usually used. These changes can reduce BOD loads by 60 to 90%. (Mattox and Livengood-North Carolina State Univ)
W70-05866

ARSENIC IN DETERGENTS: POSSIBLE DANGER AND POLLUTION HAZARD,
Kansas State Geological Survey, Lawrence; and Kansas Univ., Lawrence. Dept. of Civil Engineering.
For primary bibliographic entry see Field 05F.
W70-05894

5C. Effects of Pollution

EFFECT OF LIGHT INTENSITY AND THICKNESS OF CULTURE SOLUTION ON OXYGEN PRODUCTION BY ALGAE,
Naval Research Laboratory, Washington, D.C. Chemistry Div.
For primary bibliographic entry see Field 02K.
W70-05547

SWIMMER'S ITCH,
Wisconsin Univ., Madison. Dept. of Botany; and Wisconsin Univ., Madison. Dept. of Zoology.
Gerald F. Levy, and John William Folstad.
Environment, Vol 11, No 10, p 14-21, 1969. 5 fig, 1 tab.

Descriptors: *Human diseases, Hosts, Infection, Water pollution effects, Lakes, Rivers, Swimming, Snails, Waterfowl, Birds, Muskrats, Deer, Michigan, Copper sulfate, Wisconsin, Chemcontrol.
Identifiers: *Cercariae, *Schistosome dermatitis, Mice, Green Bay (Wis), Flatworms, Blood flukes, Aquatic snails, Swimmer's itch, Bayluscide, Schistosomiasis.

Swimmers in many northern lakes from coast to coast as well as the extreme south have developed Schistosome dermatitis, a non-debilitating skin disease caused by blood fluke cercariae, which while searching for a bird, snail, or mammal host accidentally penetrate the swimmer's skin, although man cannot act as a host. The disease is spreading due to eutrophication of waters which provides an enhanced environment for aquatic plants supporting the intermediate snail hosts and the cercariae. Copper sulphate and copper carbonate have been used to eradicate the snails but results are temporary and have induced undesirable side-effects such as the mortality of clams, which compete with the snail for food, and fishkills due to asphyxiation because the decaying vegetable matter, killed by the copper salts, reduces dissolved oxygen concentrations. Copper compound treatment may also produce more noxious forms of algae. Safer, although costlier compounds such as Balyscide, are being tried. Non-chemical measures, such as the introduction of cercariae resistant snails to prey on those infected or compete with them for food are under experiment. A continuing comprehensive research program is required to fill present gaps in information on the disease-causing parasite. (Powers-Wisconsin)
W70-05549

EUTROPHICATION TRENDS IN A CHAIN OF ARTIFICIAL LAKES IN MADRAS (INDIA),
Hydrological Research Station, Kilpauk (India).
For primary bibliographic entry see Field 02H.
W70-05550

BIOLOGICAL INTERACTION BETWEEN PLASTICIZERS AND INSECTICIDES,
Wisconsin Univ., Madison. Dept. of Entomology.
E. P. Lichtenstein, K. R. Schulz, T. W. Fuhremann, and T. T. Liang.
Journal of Economic Entomology, Vol 62, No 4, p 761-765, 1969. 2 fig, 3 tab, 10 ref.

Descriptors: *Insecticides, *Pesticides, *Toxins, *Chlorinated hydrocarbon pesticides, Chemicals, Lethal limit, DDT, Toxicity, Aldrin, Dieldrin, Chromatography.
Identifiers: *Plasticizers, Polychlorinated biphenyls, Drosophila melanogaster, Musca domestica, Aroclor.

Polychlorinated biphenyls, classified as plasticizers, include oily liquids, white crystals, and hard resins. These structural cousins of DDT are components of numerous industrial products, including some insecticides. Eleven representatives of these chemicals were tested for their toxicity and toxicological interaction with dieldrin and DDT. Many of these compounds were toxic to Drosophila melanogaster and Musca domestica, the degree of toxicity increasing with a lower content of chlorine. Addition of plasticizers, even in sublethal doses, to dieldrin and DDT augmented the toxicity of the biocides. In recent years, plasticizers have found their way to tissues of many land and water inhabitants and present now a definite treat to biological systems, especially when combined with some other synthetic chemicals. (Wilde-Wisconsin)
W70-05552

WASTE-INDUCED OXYGEN UPTAKE OF AN ALASKAN ESTUARY,
Alaska Univ., College. Dept. of Environmental Health Engineering; and Alaska Univ., College. Inst. of Water Resources.
For primary bibliographic entry see Field 02L.
W70-05556

IMPOUNDMENT WATER QUALITY CHANGES CAUSED BY MIXING,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Basic and Applied Science Program.
For primary bibliographic entry see Field 05G.
W70-05558

MANAGEMENT AND MEASUREMENT OF DO IN IMPOUNDMENTS,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Applied Science Program.
For primary bibliographic entry see Field 05G.
W70-05559

IMPOUNDMENT DESTRATIFICATION BY MECHANICAL PUMPING,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Applied Sciences Program.
For primary bibliographic entry see Field 05G.
W70-05560

CONTINUOUS CULTURE IN MICROBIAL ECOLOGY,
Woods Hole Oceanographic Institution, Mass.
H. W. Jannasch.
Laboratory Practice, p 1162-1167, October 1965. 5 fig, 1 tab, 29 ref.

Descriptors: *Water pollution effects, *Microbiology, Analytical techniques, Ecosystems, Aquatic bacteria, Carbon dioxide, Hydrogen ion concentration, Marine bacteria, Methane, Kinetics, Red tide, Protozoa, Bacteriophage, Organic acids, Proteins, Yeasts, Sea water, E coli, Growth rates, Vitamins, Systems analysis.
Identifiers: *Continuous culture, *Microbial ecology, Holotrichs, Oligotrichs, Microbial populations, Chemostats, Open systems, Fatty acids, Enrichment cultures, Chlamydobacteriales, Thiovulum, Sphaerotilus, Percolation techniques, Blooms, Acetate, Glycerol, Substrate concentrations, Dilution rate, Pseudomonas, Sugars, Dictostelium, Peptone, Vibrio, Rumen ecology, Spirillum, Achromobacter, Selenomonas, Aerobacter.

Microbial populations in natural ecosystems are conceptualized as constituting many open systems, each controlled by a specific limiting factor and affected by frequently changing external conditions. Although steady states of even uni-specific populations are improbable under such conditions, growth of natural populations is better described by open system kinetics, as in continuous cultures, than in closed, batch cultures. Useful information regarding ecosystems has resulted from investigations of continuous culture properties, both heterogeneous and homogeneous, as defined in chemical engineering. Compared with homogeneous systems, survival and enrichment of certain naturally important species in heterogeneous continuous culture depends on various more poorly defined factors, most of them unrelated to elimination of unsuccessful competitors by dilution. Under conditions approximating nature, Sphaerotilus and Thiovulum have been enriched in such experimental cultures. Heterogeneous systems have also been employed to study soil microbiology (using percolation techniques) and biological treatment of industrial wastes. Employment of four dilution rates and four concentrations of substrate (glycerol) in chemostatic experiments permitted enrichment of six different species of marine bacteria from a single sample. Homogeneous systems have also been used to study growth in rumen organisms, and steady state interactions between various organisms, employing arrays of chemostats. (Eichhorn-Wisconsin)
W70-05561

FACTORS INVOLVED IN DISPOSAL OF SEWAGE EFFLUENTS TO LAKES,
Massachusetts Inst. of Tech., Cambridge. Dept. of Sanitary Chemistry.
Clair N. Sawyer.
Sewage and Industrial Wastes, Vol 26, No 3, p 317-328, 1954. 6 fig, 3 tab, 10 ref, discussion.

Descriptors: *Lakes, *Sewage effluents, *Sewage disposal, Algae, Agricultural watersheds, Nutrients, Fertilization, Physical properties, Climate, Nitrogen, Phosphorus.
Identifiers: Algal blooms, Algae nutrition, Microcystis aeruginosa.

The significance of fertilization as the cause of algal blooming and the various physical, chemical, and biochemical factors that determine the safe loadings which may be applied are discussed. Fundamental considerations are sources of fertilizing matter reaching lakes including groundwater, surface runoff, and sewage effluents or industrial wastes; permissible nutrient or fertilizing levels; and factors considered of importance to lake behavior. Climate; physical factors of the lake including area, morphology, depth, temperature, and color; biological factors; and chemical factors including essential elements, carbon dioxide, pH, and feedback from bottom deposits are presented. The contour of the lake determines to a great extent when and how algal growth develops. For lakes that do not stratify, all nutrients are available; in stratified lakes, elements below the thermocline are sealed off from the active biological zone. Ecological relationships are an important factor in determining lake behavior. Nitrogen is needed in the greatest amount as a fertilizing element. Discussions of the paper by Professor Harold B Gotaas of University of California, Berkeley, and Professor James B Lackey of the University of Florida, Gainesville, are included. (Haskins-Wisconsin)
W70-05565

THE CHEMICAL CONTROL OF AQUATIC NUISANCES,
Wisconsin Committee on Water Pollution, Madison.
Kenneth M. Mackenthun.
Committee on Water Pollution, Madison, Wisconsin, January 1958, 64 p, 22 fig, 3 tab.

Descriptors: *Aquatic weed control, *Herbicides, *Copper sulfate, *Sodium arsenite, Nuisance algae, Snails, Legislation, Wisconsin, Chemcontrol, Pondweeds, Rooted aquatic plants, Rates of application, Application techniques, Swimming, Waterfowl, Birds, Costs, Cost-sharing.
Identifiers: Schistosome dermatitis, Copper carbonate, Cercariae, Water milfoil coontail, Wild celery, Bur reed, Duckweed, White water lily, Swimmers' itch.

A detailed description of methods of control of aquatic rooted vegetation, algae, and cercariae, causing swimmers' itch, is given. The biomass of aquatic weeds was reduced by sodium arsenite treatments in some 80 lakes with an approximate application efficiency of 150 gallons of herbicide per hour. One or more algae-eradicating treatments were given to about 40 lakes, an application of 250 pounds of commercial copper sulfate consuming one hour. Control of cercariae was successfully achieved in a limited number of lakes with a mixture of copper sulfate and copper carbonate. The efficiency of control measures was materially augmented by the use of specially designed equipment, including steel barges, portable aluminum alloy barges, spray boats and assemblies, loading booms, and gravity flow injectors. (Wilde-Wisconsin)
W70-05568

COMPREHENSIVE STUDY ON PROTECTION OF WATER RESOURCES OF LAKE TAHOE BASIN THROUGH CONTROLLED WASTE DISPOSAL,
Engineering-Science, Inc., Arcadia, Calif.; and Engineering-Science, Inc., Oakland, Calif.
For primary bibliographic entry see Field 02H.
W70-05615

FREE AMINO ACIDS AND RELATED SUBSTANCES IN MARINE ORGANISMS,
City of Hope Medical Center, Duarte, Calif.
Eugene Roberts, and J. S. Kittredge.
Available from the Clearinghouse as AD-697 976, $3.00 in paper copy, $0.65 in microfiche. Final Report, December, 1969, 24 p, 12 refs.

Descriptors: *Amino acids, Phosphorus compounds, *Aquatic microorganisms, Zooplankton.
Identifiers: *Phosphonic acids, *Anemones, Phosphonic acid/aminoethyl, Aminotransferases, Phosphonic acid/ (methylamino)ethyl, Coelenterata.

A survey of the free amino acids of over 400 tissues of marine organisms revealed a number of new compounds. An acidic amino acid was isolated from sea anemones and proved to be 2-aminoethylphosphonic acid (2-AEP). A new lipid, ceramide 2-amino-ethylphosphonic acid was isolated from sea anemones and characterized. Investigation of precursors of 2-AEP led to the isolation of a new alpha-amino acid, phosphonoalanine. The analogy of these with common nitrogenous bases led to the discovery of three more C-P compounds, N-methyl-2 AEP, N-dimethyl-2 AEP. Lipids containing the mono and trimethyl compounds were isolated. An investigation of the degradation of 2-AEP demonstrated the existence of a transaminase in Anthopleura and Tetrahymena using alpha-ketoglutarate as an acceptor. A study of the transport of aminoalkylphosphonic acids by bacteria revealed that they are taken up by the alpha-amino acid transport system. Biosynthesis of 2-AEP was shown to occur only during cell division and studies with 14C labeled precursors indicated that the most likely precursor is either phosphoenolpyruvic acid or oxaloacetate. Examination of zooplankton revealed that 3% of the total phosphorus was in C-P compounds. Cultures of coccolithophorids and dinoflagellates in labeled media demonstrated that these phytoplankton synthesize phosphonic acids. (Author)
W70-05631

CARBON SOURCES AND ALGAL COMMUNITY STRUCTURE AND METABOLISM IN A RESERVOIR UNDERGOING EUTROPHICATION BY DOMESTIC AND INDUSTRIAL EFFLUENTS,
Oklahoma State Univ., Stillwater. Reservoir Research Center.
Troy C. Dorris.
Available from the Clearinghouse as PB-191 062, $3.00 in paper copy, $0.65 in microfiche. Oklahoma State University, Oklahoma Water Resources Research Institute, Stillwater, Technical Completion Report, 1969. 112 p, 40 fig, 21 tab, 111 ref. OWRR Project No B-008-OKLA.

Descriptors: *Reservoirs, *Eutrophication, *Wastes, *Organic compounds, Analytical techniques, Chromatography, Spectrophotometry, Sewage effluents, Chlorophyll, Pigments, Productivity.
Identifiers: Keystone Reservoir (Okla), Arkansas River (Okla), Chloroform extracts, Butylmethylphenol, Steam volatile substances, Astacin-type carotenoids, Alcohol extracts.

Continuous sampling of trace aqueous organic compounds from the Keystone Reservoir and Arkansas River in Oklahoma was accomplished by the carbon adsorption method. Steam volatile compounds were determined by a combination of gas chromotograph-mass spectrometer assembly. Decreased concentration of carbon chloroform (CCE) and carbon alcohol (CAE) extracts in water of the reservoir is attributed to dilution, sedimentation, and bio-oxidation. Extracts from the Arkansas River arm contained some butyl-methylphenol (BHT), a probable constituent of sewage effluents. The annual content of chlorophyll a in the euphotic zone averaged from 33 to 59 milligram/cubic meter, indicating eutrophic nature of the reservoir.

According to estimates, 0.14 milligram ash-free (loss on ignition) surface samples contain 1.0 microgram of chlorophyll a. Contributions of phytoplankton to ash-free weight decreased with the depth of the basin. Most pronounced pigment diversity occurred in January and February. The range of gross productivity included annual means of 0.01 to 2.98 gram carbon per day and square meter. (Wilde-Wisconsin)
W70-05640

THE RATIONALE OF PALEOLIMNOLOGY,
Indiana Univ., Bloomington. Dept. of Zoology.
For primary bibliographic entry see Field 02H.
W70-05657

CULTURAL EUTROPHICATION WITH SPECIAL REFERENCE TO LAKE WASHINGTON,
Washington Univ., Seattle. Dept. of Zoology.
W. T. Edmondson.
Mitteilungen Internationale Vereinigung fur Theoretische und Angewandte Limnologie, Vol 17, p 19-32, 1969. 5 fig, 37 ref, discussion.

Descriptors: *Lakes, *Eutrophication, *Washington, Urbanization, Water pollution, Sediments, Paleolimnology, Nutrients, Productivity, Sedimentation rates, Stratigraphy, Bioindicators, Algae, Oligotrophy, Diversion, Cores, Sewage effluents, Diatoms, Phosphorus, Organic matter, Nitrogen, Chlorophyll.
Identifiers: *Lake Washington (Wash), *Cultural influences, Microcystis, Dredge samples, Anabaena, Seasonal effects, Decomposition rates, Chronology, Cladocerans, Chydorid cladocerans, Species composition, Microfossils, Competitive exclusion principle, Oscillatoria rubescens, Piston corer, Fragilaria, Melosira, Asterionella, Araphidineae, Centric diatoms, Bosmina, Diaphanosoma, Oscillaxanthin.

Eutrophication of Lake Washington by urban sewage and its subsequent recovery after installation of treatment facilities and effluent diversion are well documented. Paleolimnological evidence bearing on this case history is described. Of many diatoms occurring in cores, Fragilaria crotonensis dominates recently; Melosira italica, in the deeper (older) sediments; and Asterionella formosa occurs at all depths. No species, abundant at any depth, is missing from significant core sections. Relative composition of centric versus araphidinate groups of diatoms correlate with known lake's eutrophication history, large decreases in Araphidineae coinciding with diversion of raw sewage. Using species groups may overcome inherent disadvantages poised by considering single species as bioindicators. Animal fossils have been given little study, although Bosmina longirostris--common cladoceran in naturally or culturally eutrophic lakes--is known to be abundant throughout sediments, with increasing abundance seemingly paralleling period of enrichment. Based upon reasonably reliable marker layer, sedimentation since 1916 has proceeded at rate between 2.3 and 3.1 millimeters/year. Surficial sediments tend to be distinctly enriched in phosphorus, after interposed minimum in 1930-1940, when sewage was diverted. In general, extensive limnological data are scanty for lakes with history of eutrophication, making elucidation of paleolimnological correlatives difficult. (Eichhorn-Wisconsin)
W70-05663

EUTROPHICATION OF LAKES AND STREAMS, CAUSE AND PREVENTION (IN GERMAN),
Kantonales Laboratorium, Zurich (Switzerland).
E. A. Thomas.
Monatsbulletin des Schweizerischen Vereins Von Gas- und Wasserfachmannern, No 6/7, p 3-12, 1963. 7 fig, 24 ref.

Descriptors: *Eutrophication, *Lakes, *Rivers, *Algae, Water pollution control, Water pollution effects, Water pollution sources, Sewage, Phosphorus, Chemcontrol, Industrial wastes, Sewage treatment.
Identifiers: Ring tube, Canalization, Aluminum sulfate, Ferrichloride, Iron sulfate, Galvanizing wastes, Lake Zurich (Switzerland), Switzerland, Kilchberg (Switzerland), Zollikon (Switzerland), Lake Tegern (Bavaria), Lake Schlier (Bavaria), Lake Zell (Austria), Lake Hall wiler (Switzerland).

Water pollution was recognized in some countries a century ago when Zurich Kanton, Switzerland, enacted a law in 1881. While mechanical and biological treatment of sewage are the most generally used methods of water purification and eutrophication reversal, the resultant effluents still promote algae and higher water plants. Lakes surrounded by communities benefit by sewage canalization circling the lake, a process used for 50 years for a portion of Zurich and adjacent communities of Kilchberg and Zollikon, totaling a 50,000 population. Large lakes and those with irregular shorelines receiving sewage as well as nutrient-rich tributary streams require phosphate removal from sewage by aluminum sulfate, by ferrichloride, or by a combination of iron chloride and iron sulfate. Tests to precipitate phosphate in sewage proved promising, especially by a precipitant produced by Swiss soda plant, Zurzach, from pickle wastes, a product of galvanization (89.9% phosphate eliminated) at 1/3 to 1/4 cost of pure iron chloride. The product also served to eliminate industrial wastes and to produce a marketable commodity. Chemical control of nuisances, channeling the hypolimnion from a lake to remove nutrients, and oxygenation effects are discussed. (Auen-Wisconsin)
W70-05668

THE PRIMARY PRODUCTION IN LAKES: SOME RESULTS AND RESTRICTIONS OF THE C14 METHOD,
Uppsala Univ. (Sweden). Inst. of Limnology.
For primary bibliographic entry see Field 02K.
W70-05669

ECOLOGICAL EFFECTS OF SILVER IODIDE AND OTHER WEATHER MODIFICATION AGENTS: A REVIEW,
Michigan Univ., Ann Arbor, School of Natural Resources.
Charles F. Cooper, and William C. Jolly.
Water Resources Research, Vol 6, No 1, p 88-98, February 1970. 11 p, 4 tab, 49 ref. Contract 14-06-D-6576, Reclamation.

Descriptors: *Water pollution sources, *Water pollution effects, *Cloud seeding, *Silver iodide, *Reviews, Path of pollutants, Halides, Organic compounds, Surveys, Ions, Aquatic life, Fish, Aquatic environment.
Identifiers: Ecological effects.

The silver ion is among the most toxic of heavy metal ions, particularly to microorganisms and to fish. The ease with which Ag forms insoluble compounds, however, reduces its importance as an environmental contaminant. Ag is not likely to concentrate to harmful levels through either terrestrial or aquatic food chains. There is some possibility that Ag from cloud seeding will retard growth of algae, fungi, bacteria, and fish in fresh water; additional laboratory investigations are needed. Inhibition of aquatic microorganisms would interfere with the cycle that returns essential nutrients to the water. Ag in air and water should be regularly monitored. Iodine in AgI poses no environment danger. Organic seeding agents currently being proposed are not likely to be toxic in either the short or the long run, but dispersal of proprietary organic compounds should be prohibited unless their composition is fully revealed. (Knapp-USGS)
W70-05671

FRAGILE ESTUARINE SYSTEMS-ECOLOGICAL CONSIDERATIONS,
Texas Univ., Port Aransas. Inst. of Marine Science.
For primary bibliographic entry see Field 02L.
W70-05709

WATERBLOOM FORMING BLUE-GREEN ALGAE IN NORWAY AND THEIR IMPORTANCE IN THE STUDY OF THE INFLUENCE OF CULTURE ON THE WATER RESOURCES (IN NORWEGIAN),
Norsk Institutt for Vannforskning, Blindern.
Olav Skulberg.
English summary. Nordiske Jordbruksforskeres Forening, Vol 47, p 180-190, 1965. 2 fig, 3 tab, 20 ref.

Descriptors: *Cyanophyta, *Eutrophication, Seston, Lakes, Plankton, Water chemistry, Phytoplankton, Diatoms, Succession, Nutrients.
Identifiers: *Waterbloom, *Norway, Oscillatoria, Flagellates, Rodenessjoen (Norway), Aphanizomenon flos-aquae, Asterionella formosa, Melosira ambigua, Microcystis, Aphanothece clathrata, Merismopedia tenuissima, Anabaena.

Some common species of Cyanophyta causing water bloom in Norwegian inland waters and examples of their typical localities are discussed. Oscillatoria species have been reported previously in only a few cases as the cause of algal blooms in lakes in Norway. Plankton investigations during recent years have shown that Oscillatoria Agardhii var isothrix Skuja, Oscillatoria Agardhii Gom and Oscillatoria cf rubescens DC cause algal blooms in lakes receiving nutrients in excess of the natural supply. Some examples of blue-green algal blooms are briefly described. Considering eutrophication and lake succession, there is no slow and steady development from oligotrophic to eutrophic conditions; instead, periods of rapid change alternate with rather long periods of stability. The steplike evolution of lakes is demonstrated by corresponding changes in algae communities. The sudden occurrence of Oscillatoria cf rubescens DC in Lake Steinsfjord raises the question whether this is evidence of increasing eutrophication of the lake. Investigation of blue-green algae in Norwegian inland waters may bring important knowledge leading to the understanding of the process of eutrophication. (Jones-Wisconsin)
W70-05751

USE OF ALGAL CULTURE METHODS IN EUTROPHICATION RESEARCH (IN NORWEGIAN),
Norsk Institutt for Vannforskning, Blindern.
Olav Skulberg.
English summary. Nordiske Jordbruksforskeres Forening, Vol 47, p 211-215, 1965. 1 fig, 2 ref.

Descriptors: *Eutrophication, Algae, Cultures, Chlorophyta, Cyanophyta, Brackish water, Oligotrophy, Temperature, Light intensity, Chlorophyll, Nutrients, Conductivity, Agricultural watersheds, Sewage, Water pollution, Chemical analysis, Physical properties.
Identifiers: Bacillariophyceae, Selenastrum capricornutum Printz, Oscillatoria Vaucher, Skeletonema costatum (Grev) Cl, Chlorella ovalis Butcher, Njoer Lake (Norway), Hobol River (Norway), Van Lake (Norway).

Unialgal cultures are used in a procedure to measure the fertility of water receiving pollution with plant nutrients. The technique developed is considered a supplement to chemical and physical methods for the handling of eutrophication problems. Species from the classes of Chlorophyceae, Cyanophyceae, and Bacillariophyceae were used as test algae. Of these, Selenastrum capricornutum, which occurs widely in oligotrophic and eutrophic fresh water localities under natural conditions, was used for experimentation most extensively. Other suitable algae have been Oscillatoria Vaucher sp, Skeletonema costatum (Grev) Cl, and Chlorella ovalis Butcher. The method can be used to determine the efficiency of the water treatment plants in reducing plant nutrients in the effluent, and can measure the trophic level of water mass. Experimental methods are necessary to give a detailed understanding of

the biological phenomena which follow eutrophication. With careful and critical use of algal culture experiments, it would be possible to define numerical relations between the conditions of the water, degree of pollution and the biological situation. (Jones-Wisconsin)
W70-05752

PROGRESSIVE CHANGES IN THE CLADOCERAN AND MIDGE FAUNA DURING THE ONTOGENY OF ESTHWAITE WATER,
Indiana Univ., Bloomington.
Clyde E. Goulden.
Verhandlungen der Internationalen Vereinigung fur Theoretische und Angewandte Limnologie, Vol 15, p 1000-1005, 1964. 2 fig, 13 ref.

Descriptors: *Midges, *Lakes, Eutrophication, Pollen, Sediments, Climates, Productivity, Sheep, Hypolimnion, Anaerobic conditions, Daphnia.
Identifiers: *Esthwaite Water (England), *Cladocera, *Ontogeny, Chydoridae, Daphniidae, Bosminidae, Sididae, Polyphemidae, Leptodoridae, Deforestation, Chironomus, Sergentia, Tanytarsus, Ceriodaphnia.

Changes in total populations throughout Esthwaite Water's history and successional changes of Cladocera and midges associated with eutrophication are discussed. The Cladocera species were divided into the 'chydorids' and the 'non-chydorids,' mostly planktonic in habit. The Cladocera and midges suggest that Esthwaite Water was an oligotrophic lake during most of its development and only within the last 900 years became eutrophic under man's influence. Further, they indicate there were four periods of increased productivity during the lake's development associated with climatic or cultural changes in the drainage basin. Greater productivity is expected in these intervals, and the fact that the Cladocera correctly suggest this implies that they can be of great usefulness for determining past productivity in lakes. Cladoceran remains in lake sediments appear to be a valuable tool for paleolimnologists. They may be used to determine periods of climatic and cultural changes and for deducing past limnological conditions of a particular body of water. By studying the distribution and abundance of individual species in the sediment, we can estimate the ecological requirements of these species. This in turn will suggest fruitful areas of further research on living forms. (Jones-Wisconsin)
W70-05755

FAYETTEVILLE GREEN LAKE, NEW YORK. V. STUDIES OF PRIMARY PRODUCTION AND ZOOPLANKTON IN A MEROMICTIC MARL LAKE,
Cornell Univ., Ithaca, N.Y. Div. of Biological Sciences.
For primary bibliographic entry see Field 02H.
W70-05760

THE EUTROPHICATION OF LAKES AND THE RADICAL CHANGE OF THEIR MATERIAL CONTENT (IN GERMAN),
Waldemar Ohle.
Limnologiska foreingen i Finland, Limnologisymposion, Helsinki, 10-23, p 1-16, 1964. 10 ref.

Descriptors: *Eutrophication, *Lakes, Nutrients, Fertilization, Bacteria, Algae, Plankton, Tubificids, Calcium, Silicates, Diatoms, Winds, Nitrogen, Phosphates, Methane, Mud, Oxygen, Anaerobic conditions, Hydrogen sulfide, Iron, Fungi, Clays, Brackish water, Fisheries, Limnology.
Identifiers: Chironomids, Lake Constance, Whitefish, Wurttemberg (Germany), Plon (Germany), Lake Schlier (Germany), Lake Tegern (Germany), Germany, Finland, Sewage ring tubes.

Most North German lakes have been subject to eutrophication since early 1930's due to domestic sewage inflows and alluvial soil particles. At the end of summer stagnation, hypolimnetic oxygen is replaced by hydrogen sulfide in solution. The sediments, accumulating lake nutrients, are regarded as resultant of autochthon dynamics of metabolism and influences of regional surroundings. 3% to 5% of the mineral fertilizer washed from sloping fields are extremely high amounts for lakes with no dense plant growth, especially because of phosphate enrichment. Higher amounts of phosphorus are added by sewage, supplemented by detergents. Phosphate is a dominant production factor with nitrogen compounds of secondary importance. When large amounts of organic substances have accumulated so that dissolved oxygen in deep water is consumed by bacterial activity, larger amounts of nutrients are released from mud into hypolimnion. The more bacterial methane oxidation develops, the higher utilization of oxygen, thus more nutrients are recirculated from the mud into the water under anaerobic conditions. The increasing primary production is intensified exponentially. All sewage should be diverted from lakes by various means and chemical treatment coordinated with biological purification. (Jones-Wisconsin)
W70-05761

THE EFFECT OF CYCLING TEMPERATURES ON ELECTROLYTE BALANCE IN SKELETAL MUSCLE AND PLASMA OF RAINBOW TROUT; SALMO GAIRDNERI,
Alberta Univ., Edmonton, Alberta. Dept. of Zoology.
Daniel P. Toews, and C. P. Hickman, Jr.
Comp. Biochem Physiol., Vol. 29, p. 905 - 918, 1969. 2 tab, 11 figs., 17 refs.

Descriptors: *Rainbow trout, *Water temperature, Ions, Potassium, Sodium, Chlorides, *Fish physiology, *Electrolytes, *Acclimatization, Thermal stress.
Identifiers: Salmo gairdneri, *Plasma ions, *Muscle chloride, *Cyclic temperatures, Extra-cellular fluid volume, Muscle sodium.

Rainbow trout, Salmo gairdneri (1 1/2 yr old) were acclimated to a daily temperature cycle ranging from 8 to 18 deg C. Control fish were maintained at constant temperatures which coincided with the sample temperatures of the cycling fish. Sodium, potassium, chloride and water were measured in the plasma and muscle of all the fish. In most cases the plasma ion levels in the cycling fish did not exceed those levels of the control fish which were held at low temperatures (8-10 deg C). There was a highly significant inverse relationship between the muscle potassium and the muscle sodium levels in the cycling fish. Control fish did not exhibit this inverse relationship. Evidence from plasma and tissue concentrations of electrolytes in both the cycling and control trout indicated that cycling trout acclimated to the lowest temperatures of the cycles. (Sjolseth and Katz-Washington)
W70-05763

TOXIC EFFECT OF ELEMENTAL PHOSPHORUS ON L-CELLS CULTIVATED IN SUSPENSION,
Fisheries Research Board of Canada, Halifax (Nova Scotia). Halifax Lab.
M. F. Li, G. S. Traxler, and L. M. Langille.
Canadian Journal of Zoology, Vol. 48, (1) p 133-136, 1970. 5 figs, 1 table, 10 refs.

Descriptors: *Phosphorus, Inhibition, *Toxicity, Water pollution effects, Cultures, Fish kill, Viability, *Cytological studies.
Identifiers: *Spinner culture, *L-cells, *Cellular morphology, *Cell replication, Cytoplasm, Nuclei.

Recent mass mortalities of herring, Clupea harengus, occurring in Placentia Bay, Newfoundland, have been attributed to seawater pollution by elemental phosphorus. The effects of elemental phosphorus upon cell replication and cellular morphology were tested on L-cells grown in spinner culture. The cell replication was completely inhibited by the presence of elemental phosphorus in the culture medium at 1.25 mg/l. At 0.31 mg/l, 74% inhibition of the cell replication was observed. A calculated correlation coefficient between the percentage inhibition and the phosphorus concentration was valid at the 1% level. The phosphorus significantly altered the cellular morphology. The affected cells showed ballonization, loss of stain-binding capacity, disintegration of cytoplasm, enlarged nuclei with vacuolated nucleoli, and formation of multiple nucleated giant cells. A possible sequence of the changes was discussed. (Sjolseth-Washington)
W70-05764

CLUSTER ANALYSIS OF POTOMAC RIVER SURVEY STATIONS BASED ON PROTOZOAN PRESENCE-ABSENCE DATA,
Virginia Polytechnic Inst., Blacksburg. Dept. of Biology.
John Cairns, Jr., and Roger L. Kaesler.
Hydrobiologia, Vol. 34, p 414-432, 1969. 1 tab, 8 figs, 28 refs.

Descriptors: Water analysis, *Analytical techniques, Bioindicators, Environmental effects, On-site data collections, Surveys, Aquatic environment, Water pollution effects, *Limnology, Chemical properties, Biological properties, *Electric power plants, *Protozoa, Computer programs, *Aquatic populations, *Thermal pollution, Urbanization.
Identifiers: *Potomac River, *Cluster analysis, Jaccard coefficients.

Four high-water and six low-water limnological surveys of a portion of the Potomac River were made form 1956 to 1965; samples were collected at three stations on each survey to determine the effects of operation of the PEPCO Dickerson Power Station on the aquatic biota. Cluster analyses were made of various combinations of Jaccard coefficients relating 46 aggregations of 647 protozoan species. Similarities of aggregations of species within a survey were nearly always greater than similarities among aggregations from different surveys, indicating linear or along-stream environmental influences. Within-survey similarities for the early and late surveys were usually higher than similarities within middle-year surveys, a possible indication of environmental change at all stations, including the control, and subsequent biotic readjustment. Clustering of the 1956 aggregations, taken under high-water conditions before plant operations began, with aggregations from other surveys for any one station indicate that 1956 may have been different from other survey years. One explanation is that increased urbanization upstream from the power station after 1956 caused some environmental change. No changes in aquatic biota could be attributed to thermal pollution. (Sjolseth and Katz-Washington)
W70-05765

THE EFFECT OF TEMPERATURE ON THE RESPIRATORY AND CARDIAC RESPONSE OF THE BLUEGILL SUNFISH TO HYPOXIA,
Virginia Polytechnic Inst., Blacksburg.
Kenneth W. Spitzer, Daniel E. Marvin, Jr., and Alan G. Heath.
Comp. Biochem. Physiol., Vol. 30, p. 83 - 90, 1969. 4 figs, 1 tab, 17 refs.

Descriptors: *Water temperature, *Acclimatization, *Fish physiology, Fish behavior, Ventilation, Oxygenation, Respiration, Environmental effects.
Identifiers: *Bluegill sunfish, Lepomis macrochirus, *Heart rate, *Hypoxia, *Oxygen consumption, Bradycardia.

Bluegill sunfish were acclimated to 30 plus or minus 1, 25 plus or minus 1, and 13 plus or minus 1 deg C, and then subjected to gradually induced environmental hypoxia. Routine oxygen consumption, ventilation rate and heart rate were measured at varying oxygen concentrations. Fish at 25 and 13 deg C showed varying degrees of oxygen independence. Those at 30 deg C exhibit oxygen dependence. During hypoxia, ventilation rate increases in

both 13 and 25 deg C fish but failed to do so at 30 deg C. Bradycaadia occurred in all acclimation temperatures. The results indicate that the environmental temperature of the bluegill significantly affects its response to gradual hypoxia. (Sjolseth and Katz-Washington)
W70-05766

CLUSTER ANALYSIS OF OCCURRENCE AND DISTRIBUTION OF INSECT SPECIES IN A PORTION OF THE POTOMAC RIVER,
Academy of Natural Sciences of Philadelphia, Pa. Dept. of Limnology.
Selwyn S. Roback, John Cairns, Jr., and Roger L. Kaesler.
Hydrobiologia, Vol. 34, p. 484-502, 1969, 8 figs, 2 tab, 22 refs.

Descriptors: *Thermal pollution, *Limnology, Surveys, On-site data collections, Aquatic environment, Water pollution effects, *Electric power plants, Computer programs, *Aquatic population, Bioindicators, *Analytical techniques, Environmental effects, Protozoa, Urbanization, *Aquatic insects.
Identifiers: *Potomac River, *Cluster analysis, Jaccard Coefficients.

Limnological surveys of a portion of the Potomac River were made from 1956 to 1965 to determine the effects of operation of the PEPCO Dickerson Power Station on the aquatic biota. Samples were collected at three stations on each of four high-water and six low-water surveys. Cluster analyses were made of various combination of Jaccard coefficients relating 50 aggregations of 370 insect species. Similarities of aggregations of species within a survey were in all cases greater than similarities among aggregations from different surveys, indicating relatively strong within-year or along-stream environmental influences. Clusters of aggregations from middle-year surveys show a greater similarity to each other than to the earlier or later surveys, possibly indicating environmental change at all stations, including the control. The marked dissimilarity of aggregations from the last survey to all others suggests biotic change in the river. One explanation is that increased urbanization upstream from the power station after 1956 caused some environmental change. No changes in aquatic biota can be attributed to thermal loading as a direct result of operation of the electric power generating station. (Sjolseth and Katz-Washington)
W70-05767

THERMAL POLLUTION: STATUS OF THE ART,
Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 05D.
W70-05778

ENVIRONMENTAL TEMPERATURE AND PLASMA ELECTROLYTE REGULATION IN THE CARP, CYPRINUS CARPIO,
Marquette Univ., Milwaukee, Wis. Dept. of Biology.
A. H. Houston, and Jane A. Madden.
Nature, Vol. 217, p969-970, March 9, 1968. 1 tab, 8 ref.

Descriptors: *Temperature, *Environmental effects, *Carp, Osmosis, Thermal pollution, Heat, Toxicity, Fish, Electrolytes, Ions.
Identifiers: Cations, Anions.

During a study of systemic aspects of the thermoacclimatory process, the relation between temperature and electrolyte-regulatory ability in a typical freshwater eurytherm, the common carp, was studied. The fish were acclimatized to 4 deg, 17 deg, 27 deg, and 33 deg for intervals of not less than 3 weeks. Both regulations and its precision were modified by temperature. Plasma sodium concentrations were a maximum at 27 deg, with a mean concentration of about 9-10 millimoles/l greater than those at 4 deg or 33 deg. By contrast, chloride concentrations increased from a mean of 115.6 millimoles/l at 4 deg C to 137.0 at 33 deg. Coupled with this the precision of chloride regulation diminshed markedly at higher temperatures. Phosphate concentration increased sharply between 4 deg and 17 deg and then diminshed slowly. Plasma calcium also increased with temperature from 1.94 millimoles/l at 4 deg to 2.54 at 33 deg. Potassium and magnesium concentrations displayed no consistent variations. The ratio of plasma chloride to total cations increased with temperature, suggesting that the concentration of some anionic species, presumably HCO3-, increases at lower temperatures. A fall in plasma osmolarity at increased temperatures, with a pronounced drop between 27 deg and 33 deg, is suggested. In contrast, the sum of all cations plus chloride steadily rose with temperature. (Novotny-Vanderbilt)
W70-05780

NEW CONCEPT FOR MANAGING AQUATIC LIFE SYSTEMS,
Virginia Polytechnic Inst., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 06G.
W70-05795

EFFECTS OF RESERVOIR IMPOUNDMENT ON WATER QUALITY,
Corps of Engineers, Savannah, Ga. Special Programs Section.
Frank H. Posey, Jr., and Jospeh W. DeWitt.
ASCE Proceedings, Journal Power Division, Vol 96, No PO1, Paper 7041, p 173-185, January 1970. 13 p, 5 fig, 10 ref, append.

Descriptors: *Water quality, *Dissolved oxygen, *Reservoirs, *Thermal stratification, Reservoir operation, Water pollution sources, Water pollution control, Reaeration, Heat balance, Water temperature, Environmental engineering, Water resources development, Mixing.
Identifiers: Reservoir reaeration.

The problem of correcting the adverse effects of thermal stratification and low dissolved oxygen content in large reservoirs and controlling physical, chemical, and biological parameters of released water from impoundments in the Southeastern United States is described. The results of water quality investigations at the Clark Hill and Hartwell Reservoirs are outlined along with predictions of quality expected at West Point Reservoir. Comparisons are made of various possible corrective solutions investigated such as: (1) Multilevel penstock intakes; (2) submerged weirs; (3) tailrace and turbine aeration; and (4) destratification systems. Emphasis is placed on a diffused air pumping system prototype equipment test at Allatoona Reservoir in North Georgia. A description is given of the destratification equipment being tested, and details of the types and methods of sampling and data processing are described. (Knapp-USGS)
W70-05883

5D. Waste Treatment Processes

WASTE WATER RECIRCULATION AS A MEANS OF RIVER POLLUTION ABATEMENT,
British Columbia Sugar Refining Company Ltd., Vancouver; and Manitoba Sugar Company Ltd., Winnipeg.
W. W. Blankenbach, and W. A. Willison.
Journal of the American Society of Sugar Beet Technologists, Vol 15, No 5, p 396-402, 1969. 3 fig.

Descriptors: *Waste water treatment, *Water pollution sources, *Industrial wastes, Sugar beets, Industrial water, Water reuse, Sludge, Settling basins, Rivers, Costs, Recirculated water, Compensation.
Identifiers: Clarifier, Fort Garry (Manitoba), Red River (Canada), Recirculation system.

A successful project by Manitoba Sugar Company, Fort Garry, Manitoba, to reduce river pollution by eliminating sugar beet processing wastes is described. The company's sewage charges exceeded $64,000 per year exerting economic pressure to reduce its pollution load. A recirculation system was put into operation in 1965. Traveling and vibrating screens remove larger organic material. A clarifier removes particulate matter and suspended solids. Lime is added at the clarifier to raise the pH to 11.5+ to improve coagulation and sedimentation. The clarifier overflow is recirculated to the flume water supply tank and the underflow is pumped to mud settling ponds. Clean water is collected in a collector ditch and returned to the clarifier. The installed cost of the system, excluding screens, amounted to approximately $300,000. Operating expense is limited to lime addition (1.5-4.5 tons per day). Concentration of dissolved solids in the recirculating water builds steadily, but levels out at about 10,000 ppm of total dissolved solids and 6000 ppm biochemical oxygen demand. The increased concentration of dissolved solids in the recirculating system is felt to produce significant savings of sugar by reducing osmotic pressure differentials. The soil in the sludge beds apparently is stabilized and no problem is expected in disposing of the dry sludge. (Haskins-Wisconsin)
W70-05551

TEMPORARY WATER CLARIFICATION SYSTEM,
Georgia-Pacific Corp., Portland, Oreg.
M. Gould, and J. Taylor.
Chemical Engineering Progress, Vol 65, No 2, p 47-49, 1969. 7 fig.

Descriptors: *Waste water treatment, *Phenols, *Industrial water, Sewage lagoons, Sewage treatment, Resins.
Identifiers: Suspended solids, Activated carbon bed, Caustic solution regenerant.

Two lagoons used to impound and store phenol wastewater by a Georgia-Pacific resin plant at Conway, North Carolina, reached the capacity where continued use could cause overflow and subsequent serious pollution to a nearby stream. Waste water analysis showed 1400 ppm suspended solids and 2500 ppm phenol. Laboratory investigation indicated a two-stage clarification process followed by absorption with granular carbon. Addition of 1.0-1.5 milliliter sulfuric acid per gallon followed by 24 hour retention reduced suspended solids to less than 50 ppm. Adsorption tests showed 300 granular activated carbon removed phenol and color completely. Field trials showed carbon's working capacity 20% by weight and confirmed that absorbed phenol and total organic carbon could be removed from the activated carbon with 2.5 bed volume of hot caustic regenerant. On the basis of the laboratory and field trials, a temporary treatment system was installed and put into operation in September 1968. The makeshift system proved a superior way to handle plant wastes. Successful pilot operation has resulted in a proposal to install a permanent 25 to 50 gallon/minute system designed for continuous treatment. (Haskins-Wisconsin)
W70-05553

TERTIARY TREATMENT OF MUNICIPAL SEWAGE EFFLUENTS,
Rohm and Haas Co., Philadelphia, Pa.
Frank X. Pollio, and Robert Kunin.
Environmental Science and Technology, Vol 2, No 1, p 54-60, 1968. 2 fig, 8 tab, 8 ref.

Descriptors: *Sewage treatment, *Brackish water, *Desalination processes, Sewage effluent, Tertiary treatment.
Identifiers: Amberlite IRC-84, Dealkalization, Desal process, Bentonite, Primafloc C-7, Haddonfield (NJ).

The Desal process for the desalination of brackish waters using ion exchange units has been modified

so that secondary sewage effluents are renovated, producing clarified, odor-free water. The modified process effects simultaneous reduction in both the organic and inorganic mineral content of sewage water, offers operational flexibility, and can be engineered to produce water for industrial, agricultural, or domestic use. (Auen-Wisconsin)
W70-05554

FOAM FRACTIONATION,
Advanced Waste Treatment Research Program, Cincinnati, Ohio.
C. A. Brunner, and D. G. Stephan.
Industrial and Engineering Chemistry, p 40-48, May 1965. 9 fig, 4 tab, 4 ref.

Descriptors: *Foam fractionation, *Surfactants, Alkylbenzene sulfonates, Municipal wastes, Detergents, Linear alkylate sulfonate, Chemical oxygen demand, Laboratory tests, Pilot plants, Capital costs, Operating costs, Biodegradation.
Identifiers: Cationic polyelectrolyte additives, Gas-liquid feed ratios.

The scope of a research effort to apply foam fractionation theory to remove surfactants from municipal waste streams and a practical design approach to eliminate chemical oxygen demand (COD) and alkyl benzene sulfonate (ABS) are presented. Continuous runs on municipal effluents from seven treatment plants were carried out in laboratory-scale glass foam fractionation columns. The COD and methylene blue detectable ABS concentrations were determined in the feed, in the bottom product, and for some samples in the collapsed foam. The fraction removed for primary effluents for COD and ABS were 24% and 50%. For secondary effluents, COD and ABS removals were 25% and 70%. Data were collected from a pilot-scale foam separator in Pomona, California, over a 5-month period. At a gas to liquid feed rate greater than 5, about 35% of the gross organic contaminants were removed. Suspended solids and ABS each contributed about 40% of the total COD removed and therefore roughly 20% of the total organic material separated was soluble non-ABS organics. An average ABS removal of about 70% can be expected. The addition of selected cationic polyelectrolytes to the feed can improve removals. A summary of typical capital and operating costs for foam separators is given. (Haskins-Wisconsin)
W70-05562

A STUDY OF THE EFFECTS OF DIVERTING THE EFFLUENT FROM SEWAGE TREATMENT UPON THE RECEIVING STREAM,
Wisconsin Committee on Water Pollution, Madison.
Kenneth M. Mackenthun, Lloyd A. Lueschow, and Clarence D. McNabb.
Transactions of Wisconsin Academy of Sciences, Arts and Letters, Vol 49, p 51-72, 1960. 9 fig, 1 tab, 8 ref.

Descriptors: *Sewage effluent, *Diversion, *Stream, Sludge, Nitrogen, Phosphorus, Biochemical oxygen demand, Dissolved oxygen, Phytoplankton, Midges, Larvae, Worms.
Identifiers: *Madison (Wis), *Badfish Creek (Wis), Yahara River (Wis), Madison lakes (Wis).

About 20 million gallons of effluent per day from the Madison, Wisconsin, sewage plant were diverted into a small stream, Badfish Creek, reconstructed to accommodate a flow of approximately 50 cubic feet/second. In spite of considerable current velocity, sporadic sludge deposits were formed on the creek bottom. The effluent substantially increased the water content in organic and ammonia nitrogen, phosphorus, and biochemical oxygen demand; the dissolved oxygen was reduced to a critical level many times during the summer. There was an indication that the diversion of sewage decreased the volume of phytoplankton and changed the composition of plant community. Much of the creek bottom became covered with Oscillatoria. Bottom organisms have undergone severe degradation in their balanced population, replaced in a large part by sludge-tolerant worms and midge larvae. (Wilde-Wisconsin)
W70-05564

SMALL-SCALE CLARIFICATION UNIT FOR RADIOACTIVE SEWAGE,
Oak Ridge National Lab., Tenn.
R. Schulze-Rettmer, and K. H. Rattay.
Available from the Clearinghouse as ORNL-tr-1080, $3.00 in paper copy, $0.65 in microfiche. Trans. from Atompraxis, Vol. 11, p. 320-322, 1965. ORNL trans by Kenneth S. Warren, 17 Feb 66, 4 p.

Descriptors: *Sewage, *Radioactive waste, Labeled substances, Urine, West Germany, *Wastewater-treatment.
Identifiers: *Radioactive waste processing.

For digesting the radioactive sewage effluent from a radiological hospital, a small sewage-treatment device was installed in which the biological material of the waste water was chemically oxidized. This was desirable in order to assist the decontamination process. After homogenizing the solids, the sewage was warmed to 80 degree C and potassium peroxodisulfate was added. The addition of acid was advantageous. The efficiency was similar to that of good biological sewage treatment plants. The amount of sludge occurring in the waste water was small. Both sludge and water may afterwards be decontaminated in a further treatment system. The oxidized components were sterilized, and after neutralization were no longer toxic.
W70-05629

WASTE WATER RECLAMATION PROJECT FOR ANTELOPE VALLEY AREA,
Los Angeles Dept. of County Engineer, Calif.
John A. Lambie.
Available from the Clearinghouse as PB-191 067, $3.00 in paper copy, $0.65 in microfiche. Los Angeles County Department of Engineer Report, August 1968. 225 p, 14 fig, 32 tab, 71 ref. FWPCA Project 17080---8/68.

Descriptors: *Water reuse, *Reclaimed water, *California, Water quality, Aesthetics, Recreation, Fishing, Algae, Nutrients, Turbidity, Tertiary treatment, Sampling, Monitoring, Water demand, Water supply, Arid lands, Limnology.
Identifiers: Los Angeles County (Calif).

An economically feasible waste water renovation process was developed in Los Angeles County. The tertiary treated product water is pathogenically safe, esthetically pleasing and suitable for fish life. Primary use of the water will be for an aquatic recreation park, but other anticipated uses include soil reclamation, irrigation, and industrial applications. These reuses of waste water will result in the conservation of the presently diminishing fresh water supply in this arid area. All research and testing was done with the knowledge that ultimately the public must accept the concept of reuse of renovated waste water for the project to be a total success. Esthetics of the product water, including clarity, color and odor were important aspects of the treatment process. Test data demonstrate that bacteriological and viral requirements can be met. Fish have successfully survived and propagated in the test ponds. Algal growth and nutrient levels of water in the pilot ponds are considered within acceptable limits.
W70-05645

DEVELOPMENT OF A SYMBIOTIC ALGAL-BACTERIAL SYSTEM FOR NUTRIENT REMOVAL FROM WASTEWATER,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
F. J. Humenik, and G. P. Hanna, Jr.
24th Annual Purdue Industrial Waste Conference, May 6-8, Purdue University, Lafayette, Indiana, 1969. 16 p, 7 fig, 1 tab, 15 ref.

Descriptors: *Waste water treatment, *Nutrients, Algae, Bacteria, Cultures, Chemical oxygen demand, Nitrogen, Phosphates, Biomass, Symbiosis, Oxydation lagoons.
Identifiers: *Chlorella pyrenoidosa, Synthetic sewage feed, Symbiotic relationships.

An algal-bacterial culture, developed by inoculation of wastewater with Chlorella pyrenoidosa, proved to be efficient in removing certain nutrients from the effluents. Under optimum conditions, the algal-bacterial floc settled very rapidly, yielding a clear supernaut. The average removal of phosphates, however, was less than 3%. Maximum removal of chemical oxygen demand and organic nitrogen was obtained during unaerated operation with harvesting. The biomass oxidation required 1.27 milligrams of oxygen/milligram of solids. Supplemental aeration failed to improve either removal or conservation of nutrients. The term 'symbiotic culture' was introduced on the basis of a steady-state equilibrium in the oxygen concentration, maintained by photosynthetic oxygenation and total respiration. (Wilde-Wisconsin)
W70-05655

CASUAL OBSERVATIONS OF PROTOZOA IN TERTIARY SEWAGE TREATMENT,
Illinois State Water Survey, Peoria. Water Quality Section.
Ralph L. Evans, and Davis B. Beuscher.
Presented at 62nd Annual Meeting of the Illinois State Academy of Science, Millikin University, Decatur, April 25, 1969. 17 p, 6 fig, 2 tab, 18 ref.

Descriptors: *Tertiary treatment, *Sewage, *Biochemical oxygen demand, *Sewage lagoons, Protozoa, Flocculation, Suspended load, Turbulence, Dissolved oxygen.
Identifiers: Rhizopoda, Flagellata, Ciliophora, Ciliates, Illinois River, Residence time.

Tertiary sewage treatments include microstraining, land irrigation, sand filters, and tertiary sewage ponds (TSP). The latter appear to be most suitable for Illinois conditions, particularly as a method promising a reduction of 5-day biochemical oxygen demand (BOD). A 24-acre TSP was interposed between the Peoria activated sludge plant and the receiving stream, the Illinois River. This study was primarily concerned with the pond population of protozoa: Rhizopoda, Flagellata, and Ciliophora. The flagellates were the predominant organisms, exceeding 2 million/liter. The relationship between the 5-day BOD and volatile suspended solids (milligram/liter) of the pond influent (x-sub-1) and the effluent (x-sub-2) was expressed by regression equations x-sub-1 = 18.1 - 0.58 and x-sub-2 = 7.3 - 0.97, respectively. The limited effect of tertiary treatment of sewage on BOD is attributed to deficiency of oxygen and immobilization of activity of ciliated protozoa. A need for a slight increase in dissolved oxygen content of the medium is suggested. A taxonomic picture of sewage-inhabiting protozoa is presented. (Wilde-Wisconsin)
W70-05664

WASTE TREATMENT FOR THE CONTROL OF HETEROTROPHIC AND AUTOTROPHIC ACTIVITY IN RECEIVING WATERS,
Harvard Univ., Cambridge, Mass. Dept. of Water Resources.
Werner Stumm, and Mark W. Tenney.
Proceedings 12th Southern Municipal Industrial Waste Conference, Raleigh, North Carolina, p 97-111, 1963. 5 fig, 1 tab, 15 ref.

Descriptors: *Waste treatment, *Waters, *Organisms, Streams, Water pollution, Animals, Bacteria, Fungi, Algae, Floating plants, Rooted aquatic plants, Self-purification, Biochemical oxygen demand, Toxicity, Oxygen-reduction potential, Solar radiation, Energy, Carbon dioxide, Photosynthesis, Growth rate, Aerobic conditions, Anaerobic conditions, Biological treatment, Fertilization, Rivers, Sewage, Phosphorus, Nitrogen, Carbon, Aluminum.
Identifiers: Mathematical studies, Autotrophic, Heterotrophic.

The feasibility of aerobic biological waste treatment with complementary chemical treatment for flocculation of dispersed microorganisms and removal of phosphates has been experimentally corroborated. Results were obtained on the efficiency of organic carbon removed by biological and subsequent chemical treatment with alum. Chemical treatment alone (without prior biological substrate utilization) does not remove organic carbon to an appreciable extent. Bacteria, in the flocculation process, act as hydrophilic colloids. The stoichiometric relation between coagulant dose and number of microorganisms (or organic carbon of biological solids) is indicated. The required total coagulant demand is a function of both the concentration of dispersed microorganisms and the concentration of phosphorus present. Results illustrate that chemical coagulative methods can serve as a valuable complement to the biological substrate utilization processes. The complementary chemical and biological treatment is more economical than the conventional biological treatment; it is certainly more economical than a conventional bi9logical treatment followed by a third stage chemical treatment. In those cases where chemical treatment is more beneficial than biological treatment, the proposed treatment combination appears to be, even from an economical point of view, the most expedient waste purification arrangement. (Jones-Wisconsin)
W70-05750

COMPUTER AIDED DESIGN OF WASTE WATER TREATMENT PLANTS,
Michigan Univ., Ann Arbor. Dept. of Environmental Health.
Rolf A. Deininger, Robert W. Parrot, and Handi Akfirat.
Water Research, Vol 3, p 834-839, 1969. 3 fig, 2 ref.

Descriptors: *Digital computers, *Design, *Planning, *Waste water treatment, Design standards.
Identifiers: Remote terminals, Teletype.

The study proposed new applications of digital computers in the planning and design of waste water treatment plants. It reported that since these systems are numerical in nature and expressed in equations and inequalities, the rules and standards that regulate design can be stored in a digital computer where the designer interacts with the system via remote terminals. Instructions are stored in a large computer shared by many users at different geographical locations. A state agency specifies its particular design standards, they are entered in the computer, and the consulting engineer designing the plant uses the system from his offices via telephone lines. To explore these possibilities several computer programs were written which allowed the engineer to design different units of a treatment plant from a teletype terminal located in the School of Public Health at the University of Michigan. This unit was the source of all statements and all responses were printed out there. In this way, it was stated that engineers need not be familiar with any particular computer language, but have only the capability of operating a teletype terminal. (Kriss-Cornell)
W70-05777

THERMAL POLLUTION: STATUS OF THE ART,
Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.
Frank L. Parker, and Peter A. Krenkel.
Available from School of Engineering, Vanderbilt University, Nashville, Tenn, 37203--Price $4.00. National Center for Research and Training in Hydrologic and Hydraulic Aspects of Water Pollution Control, Vanderbilt University, Report No. 3, December 1959. 550 p, 37 fig, 21 tab, 582 ref. FWPCA Project 16130 ENT---12/69, Grant WP-01387-01.

Descriptors: *Thermal pollution, *Thermal power plants, *Temperature, *Cooling water, Thermodynamics, Aquatic life, *Aquatic environment, *Mathematical models, *Benefits, *Cooling towers, Model studies, Cooling.
Identifiers: Cooling ponds, Heat dissipation, Run of river cooling, Comparison of cooling methods.

This document is an assemblage of the most current published information dealing with the causes, the effects, and the control and abatement of thermal pollution. Discussion of the current and projected growth of the thermal-electric power industry demonstrates the magnitude of the problem. A brief thermodynamic description of the power cycle, and alternatives to the central generating station are included. The effects of temperatures on various aquatic flora and fauna, with emphasis on field observations; the beneficial effects of heat additions; and the effects of heated discharges on water quality and assimilation are discussed in detail. Other subjects of review include the mechanisms of heated water discharges, the prediction of heat dissipation, the modeling of heated water discharges, cooling ponds, and run of river cooling. Various conventional and new designs for cooling towers, the problems associated with cooling towers, and a comparison of various cooling methods are also included. Extensive bibliographies, as well as the needs for future research related to each specific topic are included. (See also W70-05059). (Speakman-Vanderbilt)
W70-05778

INTERNAL HYDRAULICS OF THERMAL DISCHARGE DIFFUSERS,
Tennessee Valley Authority, Norris. Engineering Lab.
Svein Vigander, Rex A. Elder, and Norman H. Brooks.
Journal of the Hydraulics Division, ASCE, Vol. 96, HY2, Proc. Paper 7085, p509-527, February, 1970. 17 fig, 3 tab, 6 ref.

Descriptors: *Diffusion, *Electric powerplants, *Hydraulics, *Pipe flow, *Discharge coefficients, Thermal pollution, Reynolds number, Model studies.
Identifiers: *Pipe flow, Spacing ratios, Friction factor, Diffusers.

The TVA Browns Ferry Nuclear Plant will discharge its heated condenser cooling waters into the Wheeler Reservoir. To protect the plant, and to keep within state and Federal temperature limits, the warm effluent will be mixed with the reservoir water through a subsurface diffuser system. The diffusers consist of three approximately 20 ft. diameter corrugated steel pipes each with 7800 2-inch holes in the wall through which all the warm water discharges will be forced. The discharge coefficient can be written as C = F (d/D, R, (U sq.)/2gE, Sn/d, Sp/d, f, k/d) where Sn and Sp are the hole spacings normal to and parallel to the corrugations, d is the hole diameter, R is the Reynolds number, D is the pipe diameter, f is the wall friction factor, k is the corrugation height, E is the total energy head inside the pipe, U is the average velocity in the pipe and g is the acceleration due to gravity. Functional relationship of these variables is determined by model study. Model tests were made for various hole sizes and numbers of holes in the axial and circumferential direction. Also described is the method used to compute the pipe diameter and hole configuration necessary to obtain uniform spatial distribution of discharge for a given flow rate and head. (Upadhyaya-Vanderbilt)
W70-05788

THE INFLUENCE OF MIXING ON THE ACTIVATED SLUDGE PROCESS IN INDUSTRIAL AERATION BASINS,
Technische Hogeschool, Eindhoven (Netherlands).
S. P. P. Ottengraf, and K. Rietema.
Journal, Water Pollution Control Federation, Vol 41, No 8, Part 2, Aug 1969. p R282-R293, 9 fig, 9 ref.

Descriptors: *Activated sludge, *Aeration, *Waste water treatment, *Biological treatment, Mixing, Flow rates, Oxygenation, Industrial wastes.
Identifiers: *Aeration basins, *Residence time, *Plug flow, *Cascade mixers, Inka aeration system, Substrate-degradation, Foam waves, Radial mixing, Reaction rate, Auto-oxidation.

Kinetic insights have been obtained to enhance wastewater treatment in activated sludge installations. Experiments show that the hydraulic regime of the Inka aeration basin (an industrial rectangular sludge aerator) approximates that of a cascade of perfect mixers. The paper deals with residence time distribution in a rectangular sludge aerator; gives a model that describes the mixing mechanism; and analyzes the influence of mixing on the substrate degradation by the activated sludge process. Profiles are determined theoretically according to Monod equations for various types of mixing conditions. The measured residence time distributions in the rectangular aerator are compared with the theoretical distributions associated with a plug flow and with a cascade of perfect mixers. It appears that the theoretical model for plug flow does not afford a good description of the experimental results obtained. The results obtained with the model of cascade of perfect mixers agree favorably with the theoretical results. Theoretical derivations presented afford basic principles for the design of an aeration basin to achieve certain conversion. It is seen that plug flow reaction will give the highest conversion with respect to substrate degradation. However, plug flow reactors can be approximated by a cascade of perfect mixers. (Shankar-Texas)
W70-05797

PHOSPHATES IN SURFACE WATERS AND DETERGENTS,
Procter and Gamble Co., Cincinnati, Ohio.
P. J. Weaver.
Journal Water Pollution Control Federation, Vol 41, No 9, Sept 1969, p 1647-1653. 10 fig, 1 tab, 10 ref.

Descriptors: *Phosphorus, *Surface waters, *Detergents, *Eutrophication, *Nutrients, Phosphorus compounds.

Phosphorus has been labeled as the key to controlling eutrophication by those in a position to set the course for future action. Phosphorus can enter surface waters from many sources. Among the major sources there are: natural sources, such as, aquatic plants, bottom deposits, runoff from forest land; man generated sources from both domestic and industrial wastewaters; runoff from urban and agricultural areas. Several of these sources, particularly the natural sources will present complex problems in control. The control of phosphorus in wastewaters may be accomplished by several means: chemical processes, biological treatment, combination chemical-biological, and several miscellaneous processes including ion-exchange, electrodialysis and distillation. Detergents are discussed with emphasis upon the role of phosphorus. Phosphates are important ingredients of detergents for several reasons; they soften water, sequester objectionable elements, emulsify oils and greases, provide alkalinity, and disperse and suspend dirt. To date no substitute has been found that performs the role of phosphates in detergent, but has been and still is sought. (Morgan-Texas)
W70-05799

SYSTEM OPTIMIZATION OF WASTE TREATMENT PLANT PROCESS DESIGN,
Weston (Roy F.), Inc., West Chester, Pa.
Chia S. Shih, and John A. DeFilippi.
Journal of the Sanitary Engineering Division, ASCE, Vol 96, N SA2, p409-421, April 1970. 7 fig, 5 tab, 5 ref.

Descriptors: *Costs, *Dynamic programming, *Optimization, *Sewage treatment, Mathematical models, Activated sludge, Trickling filter, Tertiary treatment.

A methodology of analysis is presented to produce a given treatment requirement of minimum cost. The methodology integrates dynamic programming techniques into present design principles to identify the optimal combination and efficiencies of various unit processes in a multi-stage plant. In this case optimal is defined as least cost. An advantage to the mathematical model is that it considers all unit processes at the same time for system optimization in contrast to the more common method of optimizing each unit process. An illustrative example is used in which the cost of a municipal treatment plant using primary clarification, secondary treatment (option of activated sludge or trickling filter) is minimized at $429,000. Using conventional design criteria the cost of the plant is calculated at $450,900. Cost curves are given for the unit processes employed in the plant and the point made that more reliable information concerning the cost and performances of unit processes is needed in order that treatment systems may be more effectively optimized. (DiFilippo-Texas)
W70-05800

THE PERFORMANCE OF CIRCULAR SEDIMENTATION TANKS,
Birmingham, Univ. (England).
T. H. Y. Tebbutt.
Water Pollution Control, Vol 68, No 4, p 467-474, July-Aug 1969. 7 fig, 7 ref.

Descriptors: *Sedimentation, *Hydraulic properties, Tracers, Settling basins, *Overflow, Rates, Sediment load, Suspended load.
Identifiers: *Solids removal.

Two 7.25-foot-diameter by 9.25-foot-deep sedimentation tanks, one of centerfeed design and the other peripheral feed, were operated side-by-side. The hydraulic properties and efficiencies, as determined by flow through curves using fluorescein tracer and the removal efficiencies, as determined by suspended solids and settleable solids, were determined at five surface overflow rates in the range of 480-3600 gal/sq ft day (Imperial gallons). The peripheral-feed tank removed slightly more suspended solids than the center-feed, but the differences were insignificant as compared to the variability of data. Due to increased flocculation at higher overflow rates, removal of suspended solids was found to be independent of overflow rate in the range tested, indicating that conventional surface loadings (600 gal/sq ft day) result in underloaded primary tanks. Hydraulic properties were found to be of limited value in assessing the removal of suspended solids. (DiFilippo-Texas)
W70-05801

LONGITUDINAL MIXING IN SPIRAL FLOW AERATION TANKS,
McMaster Univ., Hamilton (Ontario).
Keith L. Murphy, and Boris I. Boyko.
Journal of the Sanitary Engineering Division, ASCE, Vol 96, No SA2, p 211-221, April 1970. 6 fig, 11 ref.

Descriptors: *Dispersion, *Tracers, Activated sludge, Aeration, Sewage treatment.
Identifiers: *Plug flow, *Air flow, Detention time.

Rhodamine B tracer was introduced as a pulse into an aeration tank 270 ft long, 27 ft wide, and 15 ft deep. Tracer concentration was monitored in the effluent. Tests were performed using water from Hamilton Bay. Analysis of the tracer output curves indicated that the dispersion model described the longitudinal mixing in the tank. The dispersion coefficient was found to be independent of detention time in the range tested (4.8 to 13.3 hr). A correlation was determined between the dispersion coefficient and air flow rate in the range tested (6.4 scfm to 25.3 scfm per 1000 cu.ft. of tank volume). Both fine and coarse bubble diffusers indicated the same correlation. Analysis of data from tanks of various geometry indicated a correlation between the ratio of the dispersion coefficient and square of the tank width to the air flow rate. For a tank of conventional width and air flow rates of 15 scfm to 20 scfm per 1000 cu.ft. of tank volume the dispersion coefficient should range between 2000 and 8000 sq ft/hr. The degree of mixing existing in aerators with conventional air rates is such that they tend to approach fully mixed conditions. (DiFilippo-Texas)
W70-05802

PILOT PLANT TESTING FOR MUNICIPAL SEWAGE TREATMENT,
Killain (Elson T.) Associates, Millburn, N.J.
Robert C. Moore.
Journal of the Sanitary Engineering Division, ASCE Vol 96, No SA2, p 573-591, April 1970. 20 fig, 2 tab, 1 ref.

Descriptors: *Activated sludge, *Trickling filter, *Sewage treatment, New Jersey, Biochemical oxygen demand, Pilot plants, Biological treatment.
Identifiers: *Secondary treatment, Rahway Valley (NJ), Elizabeth (NJ).

An increase of treatment requirements to 80% removal of five-day BOD required that the 25 mgd Rahway Valley Sewage Authority, Rahway, New Jersey, and the 50 mgd joint meeting, Elizabeth, New Jersey, sewage treatment plants be converted from primary to secondary treatment. Due to industrialization the sewage is markedly different from domestic sewage and pilot plants were operated 1 1/2 years to analyze performance of both activated sludge and trickling filter. Actual trickling filter performances at both plants proved insufficient to meet effluent standards. The lowest efficiencies were observed at Rahway Valley and were believed due to a large amount of grease in the sewage. The activated sludge process proved capable of meeting the BOD standard at both plants. Periodic high alkalinity proved troublesome at the Joint Meeting, but the sources of highly alkaline wastes have been pinpointed. Design parameters arrived at include 59.5 lb BOD/1000 cu ft, suspended solids concentration of 2400 mg/l, and a food to micro-organism ratio of 0.4 at Rahway Valley. At the Joint Meeting values were 3100 mg/l suspended solids and a ratio of 0.29. The design is said to be conservative. (DiFilippo-Texas)
W70-05803

ALTERNATIVE METHODS OF FINANCING WASTE TREATMENT FACILITIES,
Union Securities and Co., New York.
W. James Lopp, II.
Journal Water Pollution Control Federation, Vol 42, No 2, p 291-297, Feb 1970.

Descriptors: *Appropriation, *Costs, *Financing, *Governments, *Interest, Legislation, Water quality, Water Quality Act, Treatment facilities, Taxes, Construction, Grants, Cities.
Identifiers: *Clean Waters Restoration Act of 1966, *Revenue bonds.

Except in the initial year (1966), the federal government has not fulfilled its authorization for appropriation. General obligation bonds, issued by local governmental units are usually restricted by constitutional, statutory or charter debt ceilings, etc. Alternate financing methods are presented to replace the unappropriated federal authorization. The proposed alternates are: first, FWPCA would transmit requitions to the Treasury Department which would be funded from the sale of second Liberty Bonds or a similar debt instrument. The limit would be the difference between amounts authorized and appropriated by Congress. The second is the establishment of two separate financing vehicles to handle federal and local governmental shares of the cost. The local government would issue its own tax-exempt bonds and the federal government would through the FWPCA sell obligations with taxable interest incomes. The third proposal involves complete local financing during construction and establishment of an independent agency to issue bonds to provide monies to retire a portion of the outstanding short-term debt; the balance would be retired from tax-exempt bonds issued by the local governmental units. Tax programs and financing methods for industrial waste treatment enacted at state levels are also cited. (Bishop-Texas)
W70-05804

TURBULENCE AND FLOCCULATION,
Technion - Israel Inst. of Tech., Haifa.
Yerachmiel Argaman, and Warren J. Kaufman.
Journal of the Sanitary Engineering Division, ASCE, Vol 96, No SA2, p 223-241, April 1970. 10 fig, 1 tab, 23 ref.

Descriptors: *Flocculation, Turbulent flow, *Coagulation, Waste water treatment, Kinetics, *Turbulence, Sewage treatment.
Identifiers: *Flocculation reactor, *Diffusion coefficient, Process design, Kaolin, Alum.

To design flocculation reactors, pilot plant test should be run to determine the configuration of the reactor, the geometry and power requirements of the stirring device, the concentration of the coagulant, and the need for floc strengthening additives. A theoretical model is presented for calculating the effectiveness of a continuous-flow reactor and validates the model with experimental test on a laboratory-scale reactor. The apparatus are four continuous-stirred tank reactors employing a suspension of 25 mg per l Kaolin powder (90% of the particles less than 40 microns) as turbid water and common filter alum (25 mg per l) as the flocculant. The results showed a minimum residence time for a given performance and an optimum value for the root mean square velocity gradient associated with a given residence time. Compartmentalization of the reactor reduced the residence time for a given performance with four compartments the residence time is about 800 sec and is 2000 sec for a single compartment. Anemometric measurements indicated a linear relationship between the mean square fluctuating velocity and the root-mean-square velocity gradient. (Waid-Texas)
W70-05805

DIFFICULTIES ASSOCIATED WITH SLUDGE DIGESTION, WITH PARTICULAR REFERENCE TO SYNTHETIC DETERGENTS,
D. W. Osborn.
Water Pollution Control, Vol 68, No 6, Nov-Dec 1969, p 662-663. 1 tab.

Descriptors: *Anaerobic digestion, *Detergents, *Sewage treatment facilities, Sludge digestion.
Identifiers: *South Africa, Mesophilic digestion.

A summary of eighteen replies received to a questionnaire circulated by the Southern African Branch to the larger local authorities in South Africa is presented. The average concentration of synthetic detergents in crude sewage was 15.1 mg/l (expressed as Manoxol OT) and 850 mg/l (range 250-3000 mg/l) in the digester contents. Some difficulties encountered included: increased volatile acids, frothing, scum formation, and odors. Also difficulties in maintaining the optimum pH and restarting digesters were noted. Work carried out by the British Water Pollution Research Laboratory indicated that over 2% detergents in a digester present serious inhibitory effects. However, in general, synthetic detergents cannot yet be incrimenated as a major source of difficulties with mesophilic digestion in South Africa. (Galwardi-Texas)
W70-05806

SLUDGE DENSITY CONTROL BY ULTRASONICS,
Southwest Suburban Sewer District, Normandy Park, Wash.
Edwin R. Sironen, and Dave Lee.
Journal Water Pollution Control Federation, Vol 42, No 2, p 298-301, Feb 1970. 4 fig.

Descriptors: *Sludge, *Pumping, *Control systems, *Sound waves, Automatic control, *Sludge

digestion, Waste water treatment, Washington, Ultrasonics, Sludge digestion.
Identifiers: Normandy (Wash), Miller Creek.

A 'sludge density controller' for control of the pumping cycle of sludge pumps to digesters was designed and installed at a wastewater treatment plant. The control device uses sound waves to sense the density of the pumped sludge, and stops the pumps when the percent solids drops below the desired value. This prevents the pumping of excess water into the digesters. The system includes an ultrasonic sensor and electronic control unit. The ultrasonic sensor contains a piezoelectric crystal transmitter and a receiver separated by a gap through which the sludge is passed. The ultrasonic sound waves transmitted across the gap are attenuated in proportion to the precent solids present. The electronic control unit activates the sensor and interprets the receiver output to control the pump relay, stopping the pump cycle when the sludge density drops below the desired percent solids. The initial design and subsequent modifications incorporated in the second model are described. The system is presently installed and operating trouble-free at the Miller Creek Sewage Treatment Plant, Normandy, Washington. The approximate cost of the unit installed is $465. (Morgan-Texas)
W70-05807

THE MANAGEMENT AND MAINTENANCE OF SMALL SEWAGE-TREATMENT WORKS,
Ronald G. Walker.
Discussion Included. Water Pollution Control, Volume 68, No 1, p 11-16, January-February 1969. 2 tab, 2 ref.

Descriptors: *Management, *Design, *Personnel, *Maintenance, *Operations, Sewage treatment, Wages, Effluent, Tertiary treatment, Sampling, Equipment.
Identifiers: *Small sewage treatment plants, Mobile gangs.

Many problems develop in the operation of small sewage treatment works because there is often no constant attention of a manager. To minimize problems, operators should keep accurate, concise records for review by the visiting manager or chemist, and management should be responsive to operators' requests. A record of running costs should be maintained, and annual reports prepared. Local districts should recruit and intensively train operators. To encourage recruitment, current wages should be raised, and working conditions improved. Local works should be stocked with sufficient and accessable equipment, and first-aid supplies should be provided. When employment of a full-time attendant is unfeasible, rotating maintenance gangs are preferable. Works should be designed to measure flows, periodically sample effluents, and produce high quality effluents in spite of variable flows. Equipment at periodically-manned works should be sturdy, simple and treated with anti-corrosive agents to minimize maintenance. Small works should provide tertiary treatment and selectively accept trade wastes to provide reliable quality effluents. (Cabe-Texas)
W70-05808

ECONOMIC ASPECTS OF SEWAGE WORKS DESIGN,
Elliott and Brown, Nottingham.
J. V. Cupit.
Water Pollution Control, Vol 68, No 2, p 166-177, March-April 1969. 5 fig, 5 tab, 4 ref.

Descriptors: *Sewage treatment, *Design, *Economics, *Annual costs, *Application, Methods, Capital costs, Interest rates, Rates, Labor, Maintenance costs, Insurance, Rent, Pumping plants, Sedimentation, Biological treatment, Activated sludge, Tertiary treatment, Sludge treatment, Sludge disposal, Trickling filters.
Identifiers: *Annuity, *Fuel and power costs, Material costs, Preliminary treatment.

The basic costs factors associated with the design of a sewage works are discussed, and the application of these cost factors to the design of individual units is considered. The concept of true cost is defined as the annual charge relative to a particular unit, and the major components of the annual cost are discussed. These include: loan debt charges; rents and rates; employment of labor; purchase of fuel and power; repair and maintenance of plant, buildings, and machinery; plant and machinery insurance; material purchases; and transportation. Consideration of the application of the cost factors includes discussions of the pumping plant, preliminary treatment units, biological treatment, tertiary treatment, and sludge treatment and disposal. Particular emphasis is placed on the topics of sedimentation, biological filters, and the activated-sludge process. General economic and engineering principles should be combined with the engineer's personal judgement in order to achieve a balanced solution of the design concept. (Denny-Texas)
W70-05809

THE TREATMENT AND CONTROL OF BLEACHING AND DYEING WASTES,
Cotton, Silk, and Man-made Fibres Research Association.
A. H. Little.
Water Pollution Control, Vol 68, No 2, p 178-189, March-April 1969. 9 fig, 3 tab, 2 ref.

Descriptors: *Textiles, *Industrial wastes, Neutralization, Sedimentation, Trickling filters, Activated sludge, *Biochemical oxygen demand, *Hydrogen ion concentration, Aeration.
Identifiers: Equalization.

The composition of textile waste liquors is studied and found to be highly variable in both flow and composition. This is due to both the variety processes in a plant and the fact that the processes are fill-and-draw. BOD and pH of waste liquors from 14 textile processes are given. Many treatment processes are discussed including: equalization, neutralization, segregation, sedimentation, and biological treatment. Neutralization can be achieved by sulfuric acid addition or carbonization with flue gas. A cascade system of neutralization tanks is necessary for proper control of pH. It may be desirable to segregate especially strong liquors or liquors toxic to biological treatment. Sedimentation in fill-and-draw tanks is desirable to continuous flow, while alum or copper as addition will improve sedimentation. A plant scale mechanical aeration biological filter plant achieved BOD reductions usually in excess of 80 percent. Average untreated BOD was 166 mg/l (range 55-354) while treated averaged 39 mg/l (range 1-289). A diffused air plant gave similar data while trickling filters of slag and Flocor medium had not been operated long enough for results. (DiFillippo-Texas)
W70-05810

NITRIFICATION,
Water Pollution Research Lab., Stevanage (England).
S. H. Jenkins.
Water Pollution Control, Vol 68, No 6, p 610-618, Nov-Dec, 1969. 8 fig, 4 tab, 4 ref.

Descriptors: *Activated sludge, *Nitrification, *Sewage, *Temperature, *Retention, Dissolved oxygen, Aeration, Industrial waste, *Biochemical oxygen demand.
Identifiers: *Nitrosomonas, *Suspended solids, Birmingham (England), Growth constants.

It is important to remove ammonia nitrogen during sewage treatment to reduce the oxygen demand on the receiving water. In the activated sludge process the nitrifying bacteria must be maintained at a certain number to obtain constant conditions of nitrification. Wash out of these bacteria was measured with nitrosomonas. It was found to occur when the retention period or the concentration of activated sludge was low and carbonaceous BOD was high. To predict whether or not nitrification would occur the mass of solids forms per unit mass of BOD in the sewage and the growth constant of the nitrifying bacteria was determined. An equation was derived utilizing different values of these parameters to determine if nitrification could occur. A high degree of nitrification was obtained with a retention period of 4 hours and 2000 and 6000 mg/l of mixed liquor suspended solids. Decreased nitrification was noted within 2 days when 2000 mg/l of mixed liquor solids were held for only 2-5 hours, however with 6000 mg/l of solids nitrification was complete in the 2 hour period. Growth constants were determined for nitrosomonas growing in activated sludge systems and different polluted waters, some enriched with activated aludge. The aeration period required for nitrification was reduced by increasing the temperature of the process or increasing the solids in the mixed liquor. (Schaub-Texas)
W70-05811

INHIBITION OF SLUDGE DIGESTION BY SYNTHETIC DETERGENTS,
Water Pollution Research Lab., Stevenage (England).
J. D. Swanwick, A. M. Bruce, and K. G. Vandyke.
Water Pollution Control, Vol 67, No 1, 1968, p 91-99. 5 fig, 3 tab, 16 ref.

Descriptors: *Inhibition, *Sludge digestion, *Alkylbenzene sulfonates, Methane bacteria, Industrial wastes, *Detergents, *Surfactants.
Identifiers: Amine.

A summary of the investigations on the inhibitory effect of synthetic detergents on the digestion process and the successful development of remedial measures is presented. Laboratory tests conducted on a domestic sludge showed that the high detergent content of the sludge was the most likely cause of difficulties in its digestion and that digestion was not reliable if the detergent content of the feed sludge was about 2%. Experiments were also conducted to compare the effects of hard and soft detergents. The test indicates that no significant proportion of either the soft or hard detergent was destroyed during digestion. The relationship between detergents and sludge solids is also illustrated briefly. Amine treatment is adopted to solve the above problem. Tests and their results are discussed. Laboratory digesters are operated under uniform conditions, whereas sewage work digesters are subjected to fluctuation in operating conditions such as temperature and other factors, all of which can lead to overloading of the methane bacteria. Reduction in the acitvity of methane bacteria in the presence of detergents may permit a rapid increase in the concentration of volatile acids leading to digester failure. Such difficulties could be overcome by the addition of amine, at a low cost. (Shankar-Texas)
W70-05812

SOLVING THE DETERGENT PROBLEM IN GERMANY,
W. Husmann.
Water Pollution Control, Vol 67, No 1, 1968, p 80-90, 3 fig, 5 tab.

Descriptors: *Detergents, *Degradation, *Sewage treatment, *Legislation, Biological treatment, Cleaning.
Identifiers: *Non-ionic detergents, Foam, Inland waters.

The law on detergents used in washing and cleansing products promulgated on 5th Nov. 1969 by the German Bundestag came into force on 1st October 1964. The law specified that anionic detergents in washing and cleansing products must be at least 80 percent degradable. From 1962-1964, when hard detergents were being used, the samples taken before and after treatment in the purification stations, showed an average degradability of only 22 percent. The new detergents (soft-detergents) indicated more than 80 percent degradability. From the results obtained in the sewage treatment

plants and in the inland waters, it was found that methods adopted by Federal Republic of Germany to solve the detergent problem has led to the expected success. The paper stresses the point that the problems of detergents can only be finally solved, if biological purification installations are built in and are used according to the regulations for all household and industrial wastes containing detergents. It is also necessary that the efforts to solve the detergent problem should not be hampered by the importation of washing products containing hard detergents. (Shankar-Texas)
W70-05813

DEVELOPMENT OF SYNTHETIC DETERGENTS BASE MATERIAL,
Shell Chemical Co. Ltd., London (England).
R. C. Tarring.
Water Pollution Control, Vol 67, No 1, 1968, p 59-65. 1 fig, 13 ref.

Descriptors: *Detergents, *Biodegradation, Sewage, Effluents.
Identifiers: *Surface active agent, *Liquid detergents, Subsidiary constituents, Legislative control.

The development of synthetic detergent during the past 25 years to encourage and assist the co-ordination of appropriate research by manufacturers of detergents and intermediate materials is emphasized. The surface active agent which is the basis of all detergent formulations is given careful consideration, at the beginning. Sodium secondary sulphate and other products which assume major importance as surface active agents, served a very useful purpose during the years 1942-1945. Research has led to the development of a new basic surface active agent, namely sodium dodecyl benzene sulfonate. With the advent of more efficient household detergents, there was a tremendous development in the rate of sales of these products especially in the 1950's. It was found that early synthetic detergents based on alkylsulphates interfered with the sewage treatment. The biodegradability of these detergents is then discussed. Mention is also made of liquid detergents and subsidiary constituents. Further research work carried out in the synthetic detergents provide a great deal of very useful cata which contribute to a better understanding of the sewage processing which have a strong influence on the design and opeartion of sewage works in the future. (Shankar-Texas)
W70-05814

ASSESSMENT OF BIODEGRADABILITY,
Water Pollution Research Lab., Stevenage (England).
G. E. Eden, G. A. Truesdale, and G. V. Stennett.
Water Pollution Control, Vol 67, No 1, 1968, p 107-123, 5 fig, 4 tab, 14 ref.

Descriptors: *Biodegradation, *Alkylbenzene sulfonates, Biochemical oxygen demand, Incubation, Sludge, *Detergents.
Identifiers: *Pilot-scale test, *Inoculum, Open-vessel test, Substrate concentration, Non-ionic detergent.

The need for proper assessment of aerobic biodegradability of synthetic detergent is emphasized. An incubation test originally using river water and later using synthetic BOD dilution water in both cases with a suitable inoculum was used to simulate the degradation of detergent during passage down a river. A considerable number of materials of commercial interest were used in the incubation tests and the results were in close agreement. With soft detergents the results were in good agreement with the results of more eloborate tests conducted in pilot-scale sewage treatment plants. With hard detergents such as Dobane PT, agreement was less good. Open vessel tests using standard BOD dilution water and various clean riverwaters as diluents and using 5 ml/l of sewage effluent as inoculum, indicated that while with BOD water the acclimatization or lag period tended to be longer more consistent results were obtained. The need for a supplementary test based on the activated sludge process to which materials fail to reach the required level of degradability in the aeration test is also stressed. (Shankar-Texas)
W70-05815

AN EXPERIMENTAL STUDY OF THE ROLE OF THE CILIATED PROTOZOA IN THE ACTIVATED SLUDGE PROCESS,
Water Pollution Research Lab., Stevenage (England).
C. R. Curds, A. Cockburn, and Jennifer M. Vandyke.
Water Pollution Control, Vol 67, No 3, 1968. p 312-329, 14 fig, 3 tab, 13 ref.

Descriptors: *Bacteria, *Activated sludge, *Flocculation, Biochemical oxygen demand, Chemical oxygen demand, Biomass, Turbidity, Protozoa.
Identifiers: *Ciliates, Suspended solids, Synthetic sewage, Domestic sewage, Aeration tank, Sedimentation tank.

Experimental methods have been adopted to determine the effect on the quality of the effluent of the addition of ciliated protozoa to protozoa-free activated sludges. The experiment is conducted in a pilot-plant using synthetic sewage as the feed. A significant drop in the number of bacteria and quantity of non-settlable suspended solids in effluents following the introduction of ciliates is observed. It is also observed that there is an increase in the removal of soluble organic complexes when ciliates are present. A second experiment was conducted using Stevenage domestic sewage to verify the results of the first experiment. The results as assessed by the following criteria, i.e., COD, the permanganate value and others proved that the results obtained in the synthetic sewage were valid. It was finally concluded that high quality of the effluents following introduction of the ciliates might be due to one of the two factors, namely that the bacteria are the food products of ciliates and secondly that ciliates have the ability to flocculate suspended matter and bacteria. It is not yet clear which of these two factors is the more important. (Shankar-Texas)
W70-05816

BIOLOGICAL FILTER WALLS: THE TEMPERATURE PROBLEM AND ITS SOLUTION,
Department of Sewerage, Johannesburg (South Africa).
R. I. Jackson.
Water Pollution Control, Vol 67, No 3, 1968. p 338-354, 12 fig, 1 tab, 16 ref.

Descriptors: *Temperature, *Tension, *Expansion, Movement, Reinforced concrete, Cantilevers, Costs, *Trickling filters.
Identifiers: *Biological filtration, *Ring-tension wall, Stone medium, Bending stress.

The reason for the high frequency of failure of biological filter walls is determined and a design is presented to avoid failure of walls in the future. Designers have recognized that the circular wall expands at high temperature, the retained stone moves forward against the wall, and subsequent contraction of the wall is resisted by the retained stone. It is observed that coefficients of thermal expansion of concrete vary with the aggregate used. Examination of the effect of temperature variation on wall tension showed that cycles of temperature changes cause cycles of wall movement away from and towards the stone fill. Movements towards the fill tend to mobilize passive pressure which can be up to sixteen times active pressure. Hence the inward movement is always less than the outward movement for the same temperature change. Repeated cycles result in progressive movement and an escalation of tension in the wall. The above problem could be solved by building a wall as a series of isolated walls, cantilevering from the base. A procedure is presented for designing different types of walls for biological filters. A less sophisticated and less expensive, is the simple vertical cantilever wall in isolated lengths with expansion gaps. (Shankar-Texas)
W70-05817

INCREASING WASTEWATER FLOW VELOCITY BY USING CHEMICAL ADDITIVES,
Western Co. of North America. Richardson, Tex. and Southern Methodist Univ., Dallas, Tex.
J. L. Overfield, H. R. Crawford, J. K. Baxter, L. J. Harrington, and I. W. Santry, Jr.
Journal of the Water Pollution Control Federation, Vol 41, No 9, Sept 1969. p 1570-1585, 17 fig, 1 tab.

Descriptors: *Additives, *Flow rate, *Waste water, *Algae, *Sludge, Storms, Turbulence, Pilot plants, Bacteria, Sedimentation, Toxicity, Cost-benefit analysis.
Identifiers: *Polymers, *Biological life, *Algae blooms, *Fish toxicity test, Sludge drying, Solids-settling, Economic advantage, Temperature-effect.

Practical methods have been developed to increase waste water flow velocity by using chemical additives without increasing the energy needed to move the liquid. Existing sewer line flow can be increased by using polymer additives that would increase the solid removal effectiveness at treatment plants. A 100 ft long 6 in sewer line test facility along with 25,000-gal controlled-temperature reservoir is used to determine the increased water flow with addition of chemical additives. There is a rapid increase up to 24 times the normal flow. Flow could be increased by a factor of 2 or more by using concentrations of additives between 45 and 200 ml/l. The cost/benefit analysis for a given example shows that the cost of rectifying overflow from a constriction by using an additive injection system, is less than half the prorated cost of constructing a parallel pipe system to relieve the condition. However, if the overflows occur ten times a year, the additive injection system becomes more expensive. Biochemical studies conducted indicate that additives do not affect adversely the waste water bacteria, fish, or promote algae growth. Further, the additives improve waste water settling and sludge drying rates. Additive injection system, through preferable economically in many cases, cannot be applied as a long term solution. (Shankar-Texas)
W70-05819

THE DESIGN, CONSTRUCTION, AND OPERATION OF EXTENDED-AERATION PLANTS,
Peters, G. D. (Engineering) Ltd.
B. Storch.
Water Pollution Control, Vol 68, No 1, p 40-50, Jan-Feb 1969. 4 ref.

Descriptors: *Activated sludge, *Operation and maintenance, *Design, *Construction, Aeration, Waste water treatment, Aerobic conditions.
Identifiers: *Extended aeration, Aerobic digestion.

The design of an extended aeration plant is discussed including: inlet, aeration tank, aeration to settling transfer, inlet to settling tanks, settling tank, sludge return, surface skimming, effluent withdrawal, and excess sludge handling. Excess sludge handling is treated at length including aerobic digestion. Physical descriptions and recommended dimensions for various components and equations for several calculations are given. Recommendations are made for materials to be used, positioning of equipment and other facets of construction. Plant start-up is described and a checklist for operation and maintenance is given. (DiFilippo-Texas)
W70-05820

AN INVESTIGATION INTO UPWARD-FLOW FILTRATION.
West Hertfordshire Main Drainage Authority, Rickmansworth (England).
Richard Wood, William S. Smith, and J. K. Murray.

Water Pollution Control, Vol 67, No 4, 1968. p 421-428, 3 fig, 7 tab, 2 ref.

Descriptors: *Sewage treatment, *Filtration, *Biochemical oxygen demand, *Activated sludge, Biological treatment, Pilot plants, Humus, Reaeration, Effluents, Flow rates, Filters, Algae.
Identifiers: *Upward flow, Putrescibility test, Body Immedium filter, Back-washing.

Sewage treatment authorities are increasingly being required to produce higher quality effluents from increasing volumes of stronger sewages. Enlarged activated sludge plant is designed to produce fully nitrified effluent of low solids content, to which could be added additional activated sludge solids. This makes it possible to carry out an investigation of upward-flow sand filtration. A Body Immedium filter is used to determine the effectiveness in filtering a high-quality effluent containing a wide range of activated sludge concentrations. Satisfactory removals of coarser activated sludge are obtained. By dosing the filter with artificially high proportions of well-oxidized activated sludge, high percentage removals are obtained. Although the unit is manually controlled, this type of filter lends itself to automated operation and provided that the feed liquor is of high quality and only contaminated with solids, very high quality effluents can be produced. (Shankar-Texas)
W70-05821

A SECOND-ORDER EQUATION, NOT BASED ON ULTIMATE OXYGEN DEMAND, DESCRIBING THE FIRST PHASE OF OXYGEN UPTAKE IN BIOCHEMICAL OXYGEN DEMAND REACTIONS,
Newcastle-upon-Tyne Univ. (England).
James R. Simpson.
Water Pollution Control, Vol 67, No 4, 1968. p 433-453, 14 fig, 2 tab, 12 ref.

Descriptors: *Biochemical oxygen demand, *Bioassay, *Biological treatment, *Respiration, Equilibrium, Microorganisms, Metabolism.
Identifiers: *Oxygen uptake, *Oxidation/synthesis, *Respirometer, Confined growth, Normal growth, Suspended solids.

The use of respirometer systems for the determination of oxygen-demand values of waste waters and aerobic biological systems are discussed in detail. The respirometer described has good sensitivity and great ease for withdrawing samples for analysis during a run. Reproducibility of results from settled sewage is excellent, with a maximum difference of 1.11 percent from the mean at 120 hours. A second order equation, not based on ultimate oxygen demand, describing the first phase of oxygen uptake in biochemical oxygen demand reactions is proposed. The proposed formula relating the rate of reaction to the substrate concentration and to the population of organisms, gives an excellent fit to the observed data for the first part of the reaction. The significant feature of the formula is that the ultimate oxygen demand is not required but the removable oxygen demand must be determined. In the given formula the value of a conversion constant is a function of the substrate and the organisms effecting treatment. When the values of the constants and the overall rate of metabolic processes have been determined for various systems, the critical oxygen uptake value and the time when it occurs can be calculated from a minimum of data obtained from the beginning of an experiment. (Shankar-Texas)
W70-05822

THE DESIGN AND OPERATION OF A PLATING WASTE TREATMENT PLANT,
Flight Refueling Ltd., Wimborne (England).
M. Tanner.
Water Pollution Control, Vol 67, No 4, p 401-406, 1968, 4 fig.

Descriptors: *Waste treatment, *Design, *Flow rate, Sewage, Ion exchange, Additives, Wetting, Sludge, *Treatment facilities, Settling basins, Demineralization.
Identifiers: *Contamination level, *Rinse tanks, Settlement tanks, Automatic dosing, Carbon filtration, Wetting agents, Plating waste.

Specific design and operational problems are discussed in the treatment of effluent discharges from a plating factory at Wimborne. Initially, contamination levels were prescribed and direct discharge into the sewerage system was authorized. Then consideration was given to the direct treatment of waste at the factory. Contamination levels in the waste and the quantity of the water required for the treatment were calculated. Ion-exchange resin treatment plant was chosen for the treatment of the waste. Treatment of cyanide waste which cannot be done with ion-exchange resin was carried out at the second part of the plant, by dosing with 5% lime slurry to adjust the pH to 11 and, this is followed by another chemical treatment. After settlement of the sludge overnight, dewatering of the sludge is accomplished in separate holding tanks and the clear supernatant water is passed on to the sewer. Efficiency of this ion-exchange system over shadows its high cost. The savings in water alone amounts to 5, 400,000 gallons per year. Further, settlement of the sludge overnight enables the small amount of effluent to be discharged at a slow rate giving better dilution with the sewage. Another advantage of treating plating waste is that the use of de-ionized water for make-up of baths and in rinsing tanks gives better quality plating and easier maintenance of equipment. (Shankar-Texas)
W70-05823

PLANT-SCALE POLYELECTROLYTE TREATMENT OF WASTEWATER USING STREAMING CURRENT CONTROL,
Robert S. Kerr Water Research Center, Ada, Okla; Dow Chemical Co., Midland, Mich; West Virginia Univ., Morgantown; and Illinois Inst. of Tech., Chicago.
Charles P. Priesing, Ralph V. Wolfe, William A. Sack, and Sheldon Kelman.
Journal Water Pollution Control Federation, Vol 41, No 8, Part 1, Aug 1969. p 1524-1532, 13 fig.

Descriptors: *Waste water treatment, *Sludge digestion, Biochemical oxygen demand, Feeding rate, Sampling, Flocculation, Instrumentation.
Identifiers: *Polyelectrolytes, *Streaming current, *Detector, Automatic, Waste water sample system, Feeding system, Hydraulic flow.

Determination is made on the applicability of an automated streaming current detector (SCD) to control the feeding of the polyelectrolyte in a full-scale operation, and specifically, the degree of treatment attainable with a flocculant (the Dow Chemical Company's Purifloc R (registered trademark) C31) at various pre-selected streaming current detector readings. A 450-gal automatic dilution and storage system is used for flocculator feed at a 50-mgd chemical coagulation plant with separate sludge digestion. Streaming current detector (SCD) senses the waste H2O flow and transmits electrical signal, to a variable speed drive unit which drives the polyelectrolyte solution delivery pumps. The raw waste water samples are analyzed for carbon concentration while the effluent samples are analyzed for carbon concentration and biochemical oxygen demand. Effluents containing 50 mg/l BOD and 42 mg/l carbon were obtained at a streaming current reading of 0. Sampling techniques used in the study are explained. Lower doses of flocculant are required in full-scale plant than in the laboratory sutdies. (Shankar-Texas)
W70-05825

PYROLYTIC ANALYZER DETECTS ORGANIC MATTER IN WASTEWATERS,
North American Rockwell Corp., Canoga Park, Calif; and Los Angeles Bureau of Sanitation, Calif.
Kurt H. Nelson, Ilhor Lysyj, and Joe Nagano.
Water and Sewage Works, Vol 117, No 1, p 14-18, Jan 1970. 6 fig, 3 tab, 7 ref.

Descriptors: *Waste water treatment, *Organic matter, *Volatility, *Effluents, *Laboratory equipment, *Biochemial oxygen demand, *Chemical oxygen demand, Treatment facilities, Operational, Pre-treatment (Water), Organic loading.
Identifiers: *Pyrolysis, *Pyrolytic analyzer, *Organic analyzer, *Instrument design, *BOD5 test, Hydrogen-flame ionization detector, Raw sewage, Primary effluents, Secondary effuents, Hyperion Treatment Plant (Los Angeles), Fuctionality tests.

Operation of wastewater treatment plants needs rapid acquisition of data on essential parameters and variables including the organic load in the process stream. The organic load can be quickly measured with a new instrument designed on the principle of fragmentation of the organic matter by direct pyrolysis in the presence of water. The measurable volatile organic fragments produced are summed with a detector specific for organics. These data can be converted expressed as BOD through calibration. The primary advantage of the organic analyzer for measurement of the organic load is its capability for instantaneous or continuous data acquistion, and elimination of extensive sample preparation or pretreatment. The simplicity and compactness of the instrument is an added major advantage. A series of four to six injections into the pyrolysis chamber is adequate for waste water analyses. Field tests of the pyrolytic analyzer were made on raw sewage samples primary and secondary effluents at the Hyperion Treatment Plant, Los Angeles, California. Pyrolytic analyzer results were compared to regular BOD5 test results. For the raw sewage tests the average difference was 4.1%; for primary effluents-6.8%; for secondary effluents-the pyrolytic results average about twice the BOD5 results. Possible reasons for discrepancies are discussed. (D'Arezzo-Texas)
W70-05826

SOME EXPERIENCES IN THE CONSOLIDATION OF SURPLUS ACTIVATED SLUDGE,
Manchester Corp. (England). Rivers Dept.
Peter Brown, and Alan Thomas.
Water Pollution Control, Vol 68, No 2, p 203-211, March-April, 1969. 2 fig, 6 tab, 4 ref.

Descriptors: *Activated sludge, *Sludge disposal, Consolidation, Centrifugation, Flotation, Heat treatment, Sludge treatment, Sludge digestion, Sludge.
Identifiers: *Polyelectrolytes, Davyholme Works, Supernatant, Manchester (England).

Increasing the proportion of activated sludge solids at the 68 MGD Davyholme Works of the City of Manchester from 17 to 46 percent resulted in thinner sludges being obtained from the sedimentation tanks due to a reduction in the amount of supernatant. A survey was made of methods to reduce sludge volumes including: polyelectrolyte flocculants, pressure flotation, centrifugation and heat treatment. Polyelectrolytes increased the settling rate of both digested and activated sludge, but had no effect on ultimate solids control. Pressure flotation yielded sludge solids contents of 2.5 to 5.0 percent. Several centrifugation methods produced sludges of between 8 and 10 percent solids. Heat treatment followed by 24 hours of settling produced sludges of 7.7 to 12.2 percent solids. Modification made on the plant was to divert excess activated sludge from the primary settling tanks to separate consolidation tanks using periodic sludge withdrawal. The consolidated activated sludges contained 6.5 percent solids. The activated sludge used in the trials had treated sewage containing large amounts of chemical wastes. (DiFilippo-Texas)
W70-05827

OPERATOR CERTIFICATION AND TRAINING IN THE UNITED STATES OF AMERICA,
Water Pollution Control Federation, Washington, D.C.
Ralph E. Fuhrman.
Water Pollution Control Vol 68, No 5, p 556-559, Sept-Oct 1969, 2 ref.

Descriptors: *Training, *Waste water treatment, *Operations, Standards, Regulation, Schools (Education), Treatment facilities, Permits.
Identifiers: *Voluntary certification, *Mandatory certification, Plant operation, Operator.

Efficient water pollution control depends upon good operation of the treatment plant. Certification of operators is either voluntary or mandatory in states which have certification programs. At best only about 50 percent of the operators can be certified with a voluntary program. Mandatory programs benefit the state agency, employer, and employee. Program problems include the time required, legislation, agreement among proponents, manpower and money for administration and training, support of authorities, and a reserve of trained operators during establishment of a program. Training in Illinois has an informal approach with on-the-job training. Texas holds annual short schools and short schools throughout the State at or through Texas A and M University. Certification can raise the performance level of operators and provide many benefits through good plant operation. (Berryhill-Texas)
W70-05828

THE ROLE OF CONTACT STABILIZATION IN THE TREATMENT OF INDUSTRIAL WASTE WATER AND SEWAGE: A PROGRESS REPORT,
Water Pollution Research Lab., Stevenage (England).
A. G. Boon.
Water Pollution Control, Vol 68, No 1, p 67-84, Jan-Feb, 1969. 5 fig, 9 tab, 19 ref.

Descriptors: *Waste water treatment, *Pilot plants, *Industrial wastes, Sewage, Activated sludge, Sludge treatment, Effluents, Nitrification, Biochemical oxygen demand, Chemical oxygen demand, Dairy industry.
Identifiers: *Contact stabilization, *Biosorption, Milk products waste, Spent metabolite, Solids concentration.

Waste water from a milk products factory and from a factory producing antibiotics by the fermentation process can be partially treated by the contact stabilization process. Pilot plant operations showed that waste water from the milk plant could be treated with average BOD removals of about 65 percent. The same pilot plant was used to treat waste water containing spent metabolite. Average BOD removals ranged from 50 to 86 percent at loadings of 0.63 to 0.34 kg BOD/kg sludge-day, respectively. Treating domestic sewage two pilot plants operated in parallel using the 'conventional' activated sludge process and the contact stabilization process gave similiar results for both methods. Loadings, suspended solids, retention times, sludge volume index, and other data are shown for all cases. Depending on the composition of the waste water and the degree of treatment desired, a careful balance between periods of contact and reaeration times should be made for the contact stabilization process. (Berryhill-Texas)
W70-05829

A NEW APPROACH TO OPERATOR TRAINING,
Sacramento State Coll., Calif.; and Santa Ana Watershed Planning Agency, Calif.
Kenneth D. Kerri, and Bill B. Dendy.
Journal Water Pollution Control Federation, Vol 42, No 2, Part 1, p 190-194, February 1970, 2 tab, 2 ref.

Descriptors: *Waste water treatment, *Training, *Operations, Effluents, Standards, Regulation.
Identifiers: *Sacramento (Calif), *Plant operation, Operator, Techniques, Homestudy.

Increasing numbers of waste water treatment facilities have created the need for a training program to help meet the skilled manpower shortages, water quality standards, and demands that plants be operated at design efficiencies. A Federal Water Pollution Control Administration grant made possible an investigation of a homestudy type training program for operators. Prepared lessons emphasize operation to meet established water quality standards and protection of the beneficial uses of the receiving waters. Operators participating proceed through one section of the lessons, answer questions, reread as necessary for a clear understanding and then proceed. Participants in the program receive occasional personal contact by the administering agency to relate the lessons to actual plant operation. Program has not been completed and evaluated as of February, 1970. (Berryhill-Texas)
W70-05830

IMPROVEMENTS IN FINE-BUBBLE AERATION FROM THE STANDPOINTS OF TECHNIQUE AND OPERATION,
Schumacher Filters Ltd., Bietigham (West Germany).
C. G. Beuthe.
Water Pollution Control, Vol 68, No. 1, p 51-58, Jan-Feb, 1969. 4 fig, 2 tab, 1 ref.

Descriptors: *Activated sludge, *Aeration, Oxygen demand, *Biological treatment, Sewage treatment.
Identifiers: *Completely mixed, *Piston flow, *Constant hydraulic loading, *Sludge loading, Diffusers, Surface aerators.

Three methods of applying the activated sludge process: (1) completely mixed, (2) conventional or piston flow, and (3) distributed sewage feed were investigated. The effects of sludge concentration, sludge loading (BOD: sludge solids ratio), and residual pollution was considered. A distribution function describing the sewage feed necessary to obtain a constant sludge loading was developed. Two plants, a piston flow process and a distributed feed process, equipped with tubular diffusers were examined to check the theoretical considerations. The results indicate that longitudinal flow, constant sludge loading and tapered aeration is required for maximum efficiency of oxygen input. Practical application of the longitudinal flow with constant sludge loading is described. Oxygen input using fine bubble aerators was shown to be equal in both sewage and clean water when the effluent is well purefied (partially nitrified) but is 10 to 20 per cent less in sewage when the effluent is only partially purified. The oxygen input was determined from the oxygen demand of the initial and final products. The relationship between oxygen demand and the degree of purification is also presented. Comparisons of fine bubble aeration and surface aeration indicates that during periods of low pollution input, the fine bubble aeration system is superior because of the lower energy required for mixing. (Bishop-Texas)
W70-05831

SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT,
Clarkson Coll. of Technology, Potsdam, N.Y.
E. Alan Cassell, and Thomas W. Walker.
Journal of the Sanitary Engineering Division, Proceedings of the ASCE, Vol 96, No SA1, p 15-26, February 1970. 7 fig, 7 tab, 13 ref.

Descriptors: *Sludge disposal, *Portland cements, *Fly ash, Compressive strength, Phosphorous, Leaching.
Identifiers: *Animal wastes, *Solidification, Bleed water, Primary sludge, Solid matrix.

Raw primary sewage sludge and chicken manure sludge were mixed with various amounts of portland cement and fly ash and allowed to cure. The technique immobilizes the sludge in a solid matrix which can be easily disposed. Data showed that it is possible to proportion mixes to produce a solid matrix of widely varying characteristics. The ratio of weight of water to cement varied from .5 to 10.55 and generally higher ratios results in: longer times to set, larger quantities of bleed water, and lower compressive strengths. The ratio by weight of sludge to cement varied from 0.0 to 0.5 and generally higher ratios resulted in: longer times to set, smaller quantities of phosphorous leached. The ratio by weight of fly ash to sludge varied from 0.0 to 8.0 and generally higher ratios resulted in: shorter times to set, and lower quantities of bleed water. Maximum phosphorus leached in a 15 day period amounted to 3.3% of the total phosphorous in the sludge. (DiFilippo-Texas)
W70-05832

THE METAZOA OF WASTE TREATMENT PROCESSES-ROTIFERS,
Florida Univ., Gainesville.
W. T. Calaway.
Journal of the Water Pollution Control Federation, Vol 40, No 11, Part 2, p R412-R422, Nov. 1968. 3 fig, 0 tab, 23 ref.

Descriptors: *Activated sludge, *Rotifers, *Microbiology, *Efficiencies, Treatment, Waste treatment, Trickling filter, Sewage treatment, Animals, Waste water treatment.
Identifiers: *Metazoa.

Different waste water treatment processes develop different characteristics fauna. The activated sludge process commonly supports Rotifers as its principal metazoa, trickling filters support populations of rotifers, round worms, and annelids, and the metazoa of lagoons very widely. Although the metazoa sometimes cause treatment problems they consume large amounts of bacteria and solids and therefore are generally helpful in treatment. They also break up biological masses and expose new areas to oxygen. The rotifers aid in keeping an actively growing bacterial population by consuming bacteria and thereby encouraging replacement growth. By consuming unflocculated bacteria, the rotifers contribute to clearer effluence. Their secretion can also contribute to flocculation of suspended materials. The bdelloid rotifers dominate as process stability is approached. (DiFilippo-Texas)
W70-05853

INDUSTRIAL USES OF NON-IONIC SURFACE-ACTIVE AGENTS,
Imperial Chemical Industries Ltd., Brixham (England).
J. H. Cruickshank.
Water Pollution Control, Vol 67, No 1, 1968, p 100-106. 1 fig.

Descriptors: *Structure, *Properties, *Biochemical oxygen demand, Surface tension, Textile, Effluents, Emulsion, Surfactants, Detergents.
Identifiers: *Non-ionic surface active agents, *Residues, *Synthetic fiber, Dyeing, Printing-process, Polymerization.

A brief outline of the properties and the industrial uses of non-ionic surface active agents is presented. Mention is made of structure and constitution of non-ionic surface-active agents. Non-ionic surface active agents have inherent advantage over anionic agents in three major respects; (1) they are less affected by high concentration of electrolytes, (2) degree of solubilization conferred by the polar groups can be varied in smaller steps, and (3) readily soluble in non-aqueous media. The removal of residues of non-ionic surface active agents in the factory effluent by biological treatment is discussed well. Non-ionic surface active agents have proved to be useful in specialized dyeing and printing process. It also finds its application in synthetic fiber industry, paper and leather industries and other industrial places. It is thought that the consumption of 100% non-ionic active agents in the U.K. in industrial uses is about 10,000 tons/year. However it should be emphasized that they comprise a relatively small part of the total tonnage of the surface active agents used by industry. (Shankar-Texas)
W70-05854

THE DESIGN OF TRADE WASTE TREATMENT PLANTS,
General Engineering Co. (Radcliffe) Ltd. (England).
J. Novak.
Water Pollution Control, Vol 67, No 3, 1968. p 257-267, 2 fig, 1 tab.

Descriptors: *Design, *Waste treatment, *Biological treatment, *Costs, Instrumentation, Settlement, Flocculation, Disposal, Industrial waste.
Identifiers: *Effluent treatment, Running swills, Chemical treatment, Neutralization, Sludge collection, Sludge dewatering.

The design aspect of a treatment plant to deal with the effluent from an electroplating shop is emphasized. The first step in designing an effluent treatment plant is the collection and analysis of representative samples of the effluent. The next step is to prepare several flow diagrams and to roughly estimate the cost of each scheme, and then select the best one. Decisions should be made on the number of separate drainage systems and then collection and conveyance of raw effluents should be considered. Having decided on the separate treatments, the designer must ascertain the individual flow rates and degree of contamination. The required degree of automation for the treatment plant is then decided. Wastes containing cyanide and chromium generally require separate pretreatment. The treated and neutralized liquors should comply with local authority requirements. Settling tanks are used to remove suspended solids, and pH of the supernatant liquors is measured before entering the sewer. The problems stated above do not deal with all the aspects of design or with all the types of effluents encountered. (Shankar-Texas)
W70-05855

PH INSTRUMENTATION AND AUTOMATION IN THE TREATMENT OF TRADE WASTES,
A. C. Stewart.
Water Pollution Control, Vol 67, No 3, 1968. p 265-268, 3 ref.

Descriptors: *Instrumentation, *Automation, *Electrodes, Industrial waste, Hydrogen ion concentration.
Identifiers: *Dip-type electrode, *Flow-type electrode, Redox-controller, Reagents.

A clear description of the control instruments available and useful advice on the selection and application of neutralization agents for the control of pH is presented. The dip-type electrode system which is described is suitable for applications where the velocity of the liquid is low. The flow-type electrode system gives less trouble as the electrodes are mounted on the top of the sampling chamber. But in this, time delay taken for the liquid to reach the electrodes is sometimes unacceptable. The paper further discusses the pH meter as a device for transforming a purely static voltage into an equivalent value of electric power. Electro-pneumatic control and electric automatic two and three-term controls used in the pH control of the effluent are then considered. Selection and application of reagents in the pH control of the trade effluents are discussed briefly. Mention is also made of Redox controller which is used to control the oxidation-reduction reactions. (Shankar-Texas)
W70-05856

THE PROBLEMS OF INDUSTRY IN TRADE WASTE TREATMENT,
Effluent Control Ltd., Birmingham (England).
G. Mattock.
Water Pollution Control, Vol 67, No 3, 1968. p 295-310, 6 fig, 2 tab, 8 ref.

Descriptors: *Waste treatment, *Mechanical control, Oil, Settlement, Ion exchange, Maintenance, Industrial waste, Sludge disposal.
Identifiers: *Biodegradable effluent, *Discharge limits, Cyanide destruction, Chromate reduction, Toxic metal, Reagent, Capital expenditure.

Industries' problems related to treatment of effluent standards are reviewed. The aim is to achieve a desired effluent quality at a minimum cost. More attention is given to the inorganic effluents, because for these, generalized methods of treatment could be adopted more readily than for organic effluents. Cyanide destruction and chromate reduction are important stages in the effluent treatment. The local authorities have the responsibility to fix the standards of the effluents. Some standards suggested are unrealistic. Conditions like low cyanide level and low excess chlorine level in the effluent are difficult to meet without using expensive equipments. pH adjustments and precipitation of toxic metal-hydroxides also give rise to many problems. Discharge limits quoted regarding the suspended solids are not very distinct. There is also distressing vagueness in the definition regarding the discharge of oil. The paper further describes in general terms some of the approaches which could be undertaken towards water conservation. Recirculation has not received favorable mention except for ion-exchange. Cost of treatment is also considered in every stage in terms of both capital outlay and operating expenditure. (Shankar-Texas)
W70-05857

ADVERSE EFFECTS OF SYNTHETIC DETERGENTS ON SLUDGE DIGESTION IN JOHANNESBURG,
Johannesburg Sewage Treatment Works (South Africa).
D. W. Osborn.
Water Pollution Control Vol 68, No 6, p 664-668, Nov-Dec 1969 2 fig, 3 tab.

Descriptors: *Anaerobic digestion, *Detergents, *Sewage treatment facilities, Neutralization.
Identifiers: *Johannesburg (South Africa), *Stearine amine, Chlorinated hydrocarbons, Thermophilic digestion.

During the last five years a decline in gas production from the anaerobic digesters has been noticed at one of the three sewage-treatment plants in Johannesburg. The concentration of synthetic detergents has shown a considerable increase over the last six years. The Johannesburg plants are operating with concentrations of synthetic detergents in the raw sludge of 1.1 to 1.2 percent of dry solids. Any further increases in detergent concentrations above this critical range must be carefully watched. The only proven method of overcoming detergent inhibition of digestion is the addition of stearine amine (octadecylamine). About 15 tons of stearine amine acetate would have to be added to the digesters in order to partially neutralize the detergent already stored in them. An additional cost of about 0.94 cent per 1000 gallons would be required for this treatment. The increased use of chlorinated hydrocarbons, which are extremely toxic to the digestion process, warrants their monitoring at sewage treatment plants. Thermophilic digestions which was used in one digester did not seem to enhance the degradation of synthetic detergents. (Galwardi-Texas)
W70-05858

A SURVEY OF THE PERFORMANCE OF SEWAGE SLUDGE DIGESTERS IN GREAT BRITAIN,
Water Pollution Research Lab., Stevenage (England).
J. D. Swanwick, D. G. Shurben, and S. Jackson.
Water Pollution Control, Vol 68, No 6, p 639-647, Nov-Dec, 1969. 13 tab, 4 ref.

Descriptors: *Anaerobic digestion, *Sewage treatment, *Performance, Facilities, Retention, Operation, Design, Temperature, Detergents, Industrial wastes.
Identifiers: *Unheated, *Mesophilic, Overloading, Anionic detergents, Great Britain.

During the last four years the Water Pollution Research Laboratory has been asked to investigate an increasing number of difficulties with anaerobic sludge digestion. A survey has made it possible to access the total population served by the anaerobic process. This report is a first assessment of the information obtained from 1400 questionaires which were circulated to all local authorities and main drainage authorities. Heated and unheated digesters were treated separately and all plants have been classified according to digester performance. Returns were received from 142 plants with heated digesters, serving populations amounting to a total of over 18 million people. The causes of 92 cases of difficulty at 63 sewage plants were classified as: trade wastes 37.2 percent, inadequate design or operation 56.2 percent, and anionic detergents 6.5 percent. The chief cause of difficulties attributed to inadequate design or operation resulted from stratification and loss of solids from the digestion tank. Overloading was also reported as the main cause for difficulties at a number of treatment plants. Loading rates of primary digesters were analyzed and tabulated. However, no correlation between loading and digester performance was found. Retention times, frequency of feeding and temperatures in primary mesophilic digesters were tabulated. Secondary digesters were analyzed for storage capacity and dewatering actually achieved. Returns were received from 104 plants with unheated digesters, serving populations amounting to a total of 1.7 million people. Twenty-four works reported difficulties caused mainly by overloading and low winter temperatures. Due to the frequency of short retention periods reported, a detailed analysis was made of this parameter and the results from 83 works were tabulated. Also, it was noted that the absence of laboratory control was more prevalent at smaller works. (Galwardi-Texas)
W70-05859

NITROGEN REMOVAL BY MODIFIED ACTIVATED SLUDGE PROCESS,
Texas Univ., Austin.
Srinivasula Balakrishnan, and W. Wesley Eckenfelder, Jr.
Journal of the Sanitary Engineering Division, ASCE, Vol 96, No SA2, p 501-512, April 1970. 14 fig, 1 tab, 10 ref.

Descriptors: *Sewage treatment, *Nitrogen, *Denitrification, *Nitrification, Activated sludge, Trickling filter, Nutrients.
Identifiers: *Contact stabilization-denitrification.

Among the means of removing nitrogen from sewage is nitrification followed by denitrification. Laboratory scale studies using synthetic substrate showed that a loading factor of 0.3 to 0.4 should not be exceeded to achieve good nitrification in activated sludge. At a MLSS of 2000 mg/l and aeration period of 8 hours complete nitrification of 70 mg/l of ammonia was observed. A 6-ft-deep laboratory-scale trickling filter achieved 72% and 52% nitrification of raw settled sewage for hydraulic loadings of 10 MGD/acre and 30 MGD/acre, respectively. Batch run studies on denitrification showed that sludge loaded with carbonaceous material is capable of bringing about higher rates of dentrification than sludge relying on endogenous respiration alone. These studies suggested a modified activated sludge process called 'contact-stabilization-denitrification.' Settled raw sewage is contacted with sludge and clarified. The clarified liquor is pumped to a trickling filter. The nitrified trickling filter effluent and activated sludge loaded with soluble and colloidal material are contacted with each other for stabilization of organic material and denitrification. Sedimentation of the denitrified liquor is provided. Overall nitrogen removals of 85% were observed in laboratory studies. (DiFilippo-Texas)
W70-05860

CALCIUM CHLORIDE IN PROCESSING OF WOOLEN YARN WORKS WASTES,
J. S. Franklin, E. Bowes, and J. F. Colville.
Chemical Trade Journal, Vol. 154, p 78-79, 1964.

Descriptors: *Centrifugation, *Calcium chloride, Waste water treatment, Filtration.

Identifiers: *Wool scouring, *Wool wastes, Screening (Filtration), Hydrocyclone, Wool grease, Fiber wastes, Wool.

The waste treatment plant installed by Patons and Baldwins Ltd. at Darlington has been operating for two years for recovery of grease by treatment with calcium chloride. The mixed waste waters are first screened to remove wool fibers and treated in a hydrocyclone to remove most of the suspended solids and then centrifuged to recover neutral wool grease before cracking with CaCl2 and filtration. The cost of the pre-coating material for the vacuum filters has been reduced by blending suitably graded wood flour with expanded perlite. Direct application of the CaCl2 to the filter bowls has been successful in preventing the slow after precipitation of calcium chloride which had been causing difficulties in the filters. (Rhodes and Livengood-North Carolina State Univ)
W70-05861

RECLAMATION OF BY-PRODUCTS IN WOOL SCOURING (IN FRENCH),
S. Neubart.
Industrie Textile, p 615-620, 1964.

Descriptors: *Floatation, *Calcium chloride, Centrifugation, Chemical treatment.
Identifiers: *Wool grease, *Wool scouring wastes, *Acidification, *Fiber wastes, Scouring waste.

The author describes the extraction of wool grease from scouring effluent by the methods of acidification, floatation, calcium chloride treatment, and centrifuging. The chemical treatment of the grease and its uses are discussed. There is a description of the traditional method of reclaiming potassium, and details of a method developed by the author are given. (Mattox and Livengood-North Carolina State Univ)
W70-05862

TREATMENT OF TEXTILE WASTE LIQUORS,
A. H. Little.
Journal of the Society of Dyers and Colourists, Vol. 83, No. 7, p 268-273, 1967.

Descriptors: *Waste treatment, *Cost analysis, Biological treatment, Surfactants, Water reuse, Test procedures.
Identifiers: *Waste liquors, *Effluent treatment, *Textile mill wastes, *Dyehouse wastes, Liquor purification, Suspended solids removal.

The character of textile waste liquors and methods that can be employed for their purifications are discussed. Although the examples are based largely on cotton processing, the methods are applicable generally. The need for mixing and balancing waste liquors is emphasized. Methods of biochemical treatment are described with some indication of the relative costs. The method usually used to remove suspended solids is described briefly, and the effects of oxidizing and reducing substances on the biochemical treatment are discussed. The ease of treatment of effluents containing surface-active agents depends on whether the agent is 'hard' or 'soft', i.e., whether the agent has a high or low BOD. If the waste is discharged to a sewer, the treatment costs depend on the size of the community in which the works is situated. The re-use of part of the effluent from textile processes and the analytical tests made on the effluent are discussed briefly. (Mattox and Livengood-North Carolina State Univ)
W70-05863

WASTE LIQUORS FROM THE MERCERIZATION OF COTTON FABRICS AND LIMITING OF WASTE WATER ALKALINITY (IN CZECH),
Jaromir Josek.
Summeries in English, German, and Russian. Vodni Hospodarstvi, Vol. 16, No. 7, p 288-291, 1966.

Descriptors: *Alkalinity, *Cost analysis, *Neutralization, Carbon dioxide.
Identifiers: *Waste liquors, *Mercerization wastes, Mercerization, Sulfuric acid, Hydrochloric acid, Ferric sulfate, Flue gases, Salt content.

In the mercerization process, the consumption of mercerization caustic depends mainly on the humidity of the fabric entering and leaving the mercerization machine. To reduce the caustic consumption, increased wringing by the machine and use of waste liquor for the dissolving of the fresh caustic are suggested. The economics of the neutralization of the waste liquor by H2SO4, HCl, FeSO4. 7H2O, and CO2 (flue gases) and the salt content of the neutralized waste water are discussed. (Mattox and Livengood-North Carolina State Univ)
W70-05865

WOOL PROCESSING AND STREAM POLLUTION,
For primary bibliographic entry see Field 05B.
W70-05866

ENERGY-INDUCED CHANGES IN AN AZO DYESTUFF WASTE,
A. I. Mytelka, and R. Manganelli.
Journal Water Pollution Control Federation, Vol. 40, No. 2, I, p 260-268, 1968, 20 ref.

Descriptors: *Waste treatment, *Gamma radiation, *Chemical oxygen demand, *Bio-chemical oxygen demand, Industrial wastes, Solid wastes.
Identifiers: *Biological oxidation, *Azo dyes, *Total organic carbon, Color reduction.

Sterilization of water and waste-water by means of radiation is based on energy induced changes in the waste and the effect of these changes on subsequent biological oxidation. The industrial waste selected for testing was an azo dyestuff mother liquor with low biodegradability and intense color. The ionizing radiation source was cobalt-60 gamma rays. Parameters investigated include total organic carbon (TOC), COD, BOD, dye concentration, color, solids, and pH. Results show a decrease in the above variables, and a waste more amenable to biological oxidation as radiation dosage increased. (Mattox and Livengood-North Carolina StateUniversity)
W70-05867

CLARIFICATION OF TEXTILE WASTES BY MEANS OF MAGNESIUM CHLORIDE (IN CZECH),
J. Nosek, and J. Krepelka.
Vodni Hospodarstvi, Vol. 9, p 556-557, 1959.

Descriptors: Alkalinity, Magnesium Hydroxide.
Identifiers: *Textile mill wastes, *Magnesium chloride, *Dyes, *Clarification agents.

Full-scale tests of clarification of textile mill wastes by means of MgCl2 showed that, in a highly alkaline medium, it is a very effective clarification agent. The use of MgCl2 is especially advisable for laboratory tests, as the color of the originally white Mg (OH)2 may be a good indicator of the quantity of dye removed. (Mattox and Livengood-North Carolina State University)
W70-05868

TREATMENT OF WASTE WATERS FROM THE TEXTILE FINISHING INDUSTRY,
N. Merkel.
Melliand Textilber, Vol. 36, p 293-294, 1955.

Descriptors: *Sedimentation, *Flocculation, *Biological treatment, *Waste water treatment, Waste treatment, Iron compounds, Sludge.
Identifiers: *Finishing wastes, *Ferrous sulfate, *Color reduction, *Dyehouse Wastes, Waste waters integration, Water softening sludge, Textile mill wastes, Dyes.

About 2/3 of the waste waters produced in a textile finishing factory are relatively unpolluted and are kept separate from the polluted waters. Heavily polluted waters are mixed in sedimentation tanks holding about 3-5 hours output. By the mixing of different types of waste waters flocculation is encouraged and is completed by addition of FeSO4, other iron solution, or sludge from water softening. Final biological treatment usually takes place in sewage works. Sufficient dilution for reduction of color is important. (Mattox and Livengood-North CarolinaState University)
W70-05869

CLARIFICATION OF TEXTILE WASTE WATERS THROUGH THE USE OF WET TRANSFER OF SLAG AND ASH FROM STEAM BOILERS (IN CZECH),
J. Nosek.
Vodni Hospodarstvi, Vol. 11, No. 8, p 358-359, 1961.

Descriptors: *Waste water treatment, *Calcium hydroxide, Boilers, Analysis.
Identifiers: *Textile mill wastes, *Wet transfer, *Ferrous sulphate.

The quality of textile waste water, clarified by wet transfer, is approximately 40% as compared with the clarification of almost 50% obtained with ferrous sulfate and calcium hydroxide. (Mattox and Livengood-North Carolina State University)
W70-05870

WATER FOR THE DYER,
For primary bibliographic entry see Field 6D.
W70-05871

DIALYSIS OF CAUSTIC TEXTILE WASTES,
N. L. Nemerow, and W. R. Steele.
10th Industrial Waste Conference, Purdue University Engineering Extension Service, No. 89, p 74-81, 1955.

Descriptors: *Dialysis, *Waste water treatment, *Alkalinity, Waste waters, Filtration.
Identifiers: *Caustic, *Sodium hydroxide, Mercerizing wastes, Kiering wastes, Dyeing wastes, Hemicellulose, Pectins, Waxes, Dyes, Vacuum evaporators, Textile mill wastes.

In processing of cotton goods the waste waters from the mercerizing, kiering, and vat dyeing of the cotton are all strongly alkaline, with high BOD and excessive mineral content, and are colored. Dialysis of the waste waters to separate pure NaOH from the impurities such as hemicelluloses, pectins, waxes, and dyes, has been successful. The Solvay-Brosites dialyser has been developed to treat textile waste waters after concentration to about 38-40 percent caustic soda in vacuum evaporators, cooling, and filtration. (Mattox and Livengood-North Carolina State University)
W70-05872

COMBINED TREATMENT OF COTTON MILL AND DAIRY WASTES WITH SEWAGE,
A. Petru.
Water Waste Treatment, Vol. 11, No. 12, p 532-533, 1968.

Descriptors: *Waste water treatment, *Biochemical oxygen demand, *Chemical oxygen Demand, *pH, Sewage, Test procedures, Two-stage activated sludge plant, Sulphur, Copper sulphate.
Identifiers: *Cotton mill wastes, *Diary wastes, *Combined treatment, Textile mill wastes, Dichromates, Permanganates, Shock loading, Potassium chromate.

The combined treatment of cotton mill and dairy wastes with sewage was evaluated by treating synthetic sewage made from dried milk and textile wastes from an operating cotton mill. The wastes were tested manometrically. These manometric tests were followed by tests in a laboratory model, two-stage activated sludge plant. The combined

waste could be effectively treated (parameter, initial value, and percent reduction in primary and secondary stage, respectively): BOD 330 mg/l, 70, 94; Chemical Oxygen Demand (dichromate) 606 mg./l., 60, 77; Chemical Oxygen Demand (permanganate) 178 mg./l, 75, 84. Initial pH was 8.8-9.6. Shock loading to alkaline pH was adequately handled. S (2-) ^{17}, Cr 1.68 (as K2Cr2O4), and Cu (as CuSO4) 41 mg./l. were without effect. Retention times of one hour in the primary and three hours in the secondary stage yielded acceptable results. (Mattox and Livengood-North Carolina State University)
W70-05874

TREATMENT OF WASTE WATERS FROM THE WOOL INDUSTRY (IN RUSSIAN),
M. N. Osherelyava.
Vodosnabzhenie i Sanitarnaya Tekhnika, No. 12, p 14-15, 1959.

Descriptors: *Waste water treatment, Lime, Biochemical oxygen demand.
Identifiers: *Wool scouring wastes, *Ferric chloride, *Clarity, Ferrous sulphate, Suspended wastes.

The composition and treatment of wool washing waste waters are discussed. Treatment with lime and ferrous sulfate is insufficient. Experiments with ferric chloride showed that this treatment increased clarity, reduced suspended matter from 3043 mg. to 435 mg/l and reduced BOD by 50%. Addition of lime was necessary only if the pH value required adjustment before discharge to a stream. (Mattox and Livengood-North Carolina State University)
W70-05875

USE OF UNICELLULAR ALGAE FOR PURIFYING WASTE WATERS FROM SYNTHETIC FIBRE UNDERTAKINGS (IN RUSSIAN),
G. M. Palamar-Mordvintseva, V. V. Grabovskaya, V. K. Marinich, and S. M. Naigauz.
Khimicheskie Volokna, No. 3, p 61-62, 1966.

Descriptors: *Waste water treatment, *Chlorella, Experiments, Waste waters, Ureas, Iron, Hydrogen sulphides, Sulphides, Biochemical oxygen demand, Calcium sulphates.
Identifiers: *Unicellular algae, *Man-made fiber plant wastes, *Effluent treatment, *Ankistrodesmus, *Food salts, Nylon-6, Magnesium sulphate, Potassium phosphate, Viscose rayon, Zinc, Carbon disulphide, Free oxygen.

Experimental work was done in the laboratory and in the open air at effluent-treatment plants of factories producing nylon-6 and viscose rayon on the use of unicellular algae (Chlorella and Ankistrodesmus). The growth of the algae in the waste waters can be stimulated by the addition of 'food' salts (urea, magnesium sulphate, and potassium phosphate). Removal of zinc, iron, hydrogen sulphide, carbond disulphide, and sulphides is 100%, the quantity of free oxygen is increased by 100-400% and the B.O.D. is reduced by 90%; only the calcium and the sulphates remain unaffected. Complete purification is achieved on the sixth day under laboratory conditions and on the third day in the open air. The work is regarded only as preliminary; no account of economic aspects has been taken. Further projected work on the possibility of cheapening the process by using by-products of the food and distilling industries is mentioned. (Mattox and Livengood-North Carolina State University)
W70-05876

CLARIFICATION OF SEWAGE FROM SYNTHETIC FIBER FACTORIES WITH THE AID OF SINGLE - CELL ALGAE (IN UKRAINIAN),
G. M. Palamar-Mordvintseva, V. K. Marinich, V. V. Grabovs'ka, and S. M. Neigauz.
Ukrains'kii Botanicheskii Zhurnal, Vol. 23, No. 5, p 56-61, 1966.

Descriptors: *Sewage treatment, *Chlorella, Hydrogen sulfide, Sulfur, Sulfides, Biochemical oxygen demand.
Identifiers: *Sewage clarification, Man-made fiber plant wastes, Experiments, Zinc, Carbon disulfide, Viscose rayon.

Experiments were conducted in open basins to confirm data obtained under laboratory conditions on the possibility of cultivating Chlorella algae on sewage from synthetic fiber production for the purpose of clarifying the sewage. Growth and development of algae and clarification of sewage were more rapid under natural conditions than in the lab. The main clarification was completed in 1 day in the presence of algae. A 3-day cultivation of the algae removed Zn, H2S, S, and sulfides (100%) and CS2 (60%) and decreased BOD by 92.5%. (Mattox-Livengood-North Carolina State University)
W70-05877

INJECTION OF RECLAIMED WASTEWATER INTO CONFINED AQUIFERS,
Toups Engineering, Inc., Santa Ana, Calif.; and Orange County Water District, Santa Ana, Calif.
G. M. Wesner, and D. C. Baier.
Journal American Water Works Association, Vol 62, No 3, p 203-210, March 1970. 8 p, 6 fig, 7 tab, 19 ref.

Descriptors: *Reclaimed water, *Injection wells, *Artificial recharge, *Saline water intrusion, *California, Water reuse, Odor, Taste, Water quality, Water pollution control, Monitoring, On-site tests, Aquifers, Groundwater movement.
Identifiers: Saline water barrier wells, Orange County (Calif).

The Orange County Water District, California has conducted research in wastewater reclamation and subsurface injection since July, 1965. The first phase of the work was intended to determine the feasibility of treating and injecting secondary effluent. The second phase has the following objectives: (1) Determine the hydraulic characteristics of the proposed injection barrier system of multipoint injection wells; (2) determine the long-term fate of reclaimed wastewater in the injection system; (3) determine the feasibility of utilizing wastewater for a barrier; and (4) determine the chemical composition of blended reclaimed water and deep groundwater. The multiple casing injection wells have performed very satisfactorily. The treated trickling filter effluent is injectable and would not cause excessive well clogging. Coliform bacteria have appeared sporadically 100 ft from the injection well, and have not been found at 245 ft. Many chemical constituents do not move conservatively in the injected water. Hardness and alkalinity increase; ammonia and other oxygen-demanding materials are significantly reduced by travel in the confined aquifer. The odor and taste which persist in the injected reclaimed water is probably the most serious deterrent to utilizing this source for injection in a barrier system. (Knapp-USGS)
W70-05880

5E. Ultimate Disposal of Wastes

SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT,
Clarkson Coll. of Technology, Potsdam, N.Y.
For primary bibliographic entry see Field 05D.
W70-05832

5F. Water Treatment and Quality Alteration

THE EFFECTS OF ELECTROLYTE POWER ON IODINE-TREATED WATER,
Naval Medical Field Research Lab., Camp Lejeune, N.C.
Ned S. Hurst.
Available from the Clearinghouse as AD-699 179, $3.00 in paper copy, $0.65 in microfiche. Interim rept., Vol 19, No. 19, Dec 69, 12 p.

Descriptors: *Electrolytes, Halogens, *Water purification, Potable water, Halogenated pesticides, Pesticides, *Water treatment, Times, Lemons.
Identifiers: *Iodine.

The influence of an electrolyte powder on iodine-treated water was investigated. When 77 gm of the electrolyte powder were placed in iodine-treated water, 12.69 mg/liter, essentially all of the free iodine was removed in 60 minutes. The effect of electrolyte powder on the germicidal action of iodine was also investigated. The results were ambiguous and further research is indicated. The powder was a mixture of sucrose, citric acid, lime flavoring, sodium chloride, calcium chloride, and potassium monophosphate.
W70-05630

WASTE WATER RECLAMATION PROJECT FOR ANTELOPE VALLEY AREA,
Los Angeles Dept. of County Engineer, Calif.
For primary bibliographic entry see Field 05D.
W70-05645

MICROBIOLOGICAL ANALYSIS OF WATER.
Millipore Corp., Bedford, Mass.
For primary bibliographic entry see Field 05A.
W70-05722

ARSENIC IN DETERGENTS: POSSIBLE DANGER AND POLLUTION HAZARD,
Kansas State Geological Survey, Lawrence; and Kansas Univ., Lawrence. Dept. of Civil Engineering.
E. E. Angino, L. M. Magnuson, T. C. Waugh, O. K. Galle, and J. Bredfeldt.
Science, Vol 168, No 3939, p 389-390, April 17, 1970. 2 p, 3 tab, 8 ref.

Descriptors: *Detergents, *Arsenic compounds, *Waste water (Pollution), Kansas, Water softening, Enzymes, Public health, Standards, Potable water, Water reuse, Water treatment, Poisons.
Identifiers: *Household detergents, Kansas River.

Arsenic in amounts of 10 to 70 parts per million was found in several common presoaks and household detergents, using the sensitive silver-diethyldithiocarbamate method. To learn whether arsenic from waste waters of detergent products was adding to pollution of the Kansas River, samples were analyzed of detergents, water from the river, and water entering and leaving both the water and sewage treatment plants in Lawrence, Kansas. Arsenic values of 2 to 8 parts per billion were measured in the river. The concentrations approach the amount of 10 parts per billion, a drinking-water standard recommended by the U. S. Public Health Service. (Lang-USGS)
W70-05894

5G. Water Quality Control

IMPOUNDMENT WATER QUALITY CHANGES CAUSED BY MIXING,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Basic and Applied Science Program.
James M. Symons, William H. Irwin, and Gordon G. Robeck.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 93, SA 2, No 5205, p 1-20, 1967. 12 fig, 1 tab, 19 ref.

Descriptors: *Eutrophication, *Pumping, *Mixing, *Thermal stratification, *Water quality, On-site data collections, Kentucky, Impoundments, Oxygenation, Water quality control.
Identifiers: Destratification, Bullock Pen Lake (Ky), Boltz Lake (Ky).

Mechanical pumping was used to artificially destratify a 2,380-acre-foot lake (Boltz Lake) in northern Kentucky. Analysis of samples taken weekly, from May to October 1965, throughout the depth of the lake, showed the influence of mixing on water quality. A nearby lake of nearly equal volume (Bullock Pen Lake), sampled similarly, was used as a control. Results showed a warming and oxygenating of the lower layers of the test lake that resulted in the precipitation of manganese and the oxidation of sulfide. Mixing neither increased the concentration of any nitrogen form, or the total hydrolyzable phosphorus, nor decreased the clarity in the surface. There was no increase in algal densities. Data on work requirements and efficiences are also given. (Auen-Wisconsin)
W70-05558

MANAGEMENT AND MEASUREMENT OF DO IN IMPOUNDMENTS,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Applied Science Program.
James M. Symons, William H. Irwin, Robert M. Clark, and Gordon G. Robeck.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 93, SA 6, No 5688, p 181-209, 1967. 12 fig, 5 tab, 52 ref, appendix.

Descriptors: *Dissolved oxygen, *Stratification, *Hydraulic equipment, *Water quality, Temperature, Impoundments, Mathematical models, Kentucky, Mixing, Time, Pumping, Reservoirs, Profiles, Thermal stratification.
Identifiers: Artifical destratification, Air-Aqua system, Compressed air, Aero-Hydraulics Gun.

A basis for the comparison of various mechanical devices used for artificially destratifying impoundments by calculating their hydraulic performance based on impoundments stability is given. Three problems are discussed for clarification: influence of size and geometry on stability, natural changes in stability with time, and the basic hydraulic inefficiency of spring mixing if cold water is raised. A mathematical model is developed for studying the dissolved oxygen budget in impoundments with a solution presented, using specially designed dissolved oxygen determination equipment. Finally, data are presented on the destratification of a 2,930-acre-foot impoundment in northern Kentucky by pumping. The hydraulic performance of the pump is calculated and the influence of mixing on the reduced substances and dissolved oxygen resources in the impoundment shown. The most favorable period for destratification is discussed. (Auen-Wisconsin)
W70-05559

IMPOUNDMENT DESTRATIFICATION BY MECHANICAL PUMPING,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Applied Sciences Program.
William H. Irwin, James M. Symons, and Gordon G. Robeck.
Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 92, SA 6, No 5032, p 21-40, 1966. 14 fig, 2 tab, 23 ref.

Descriptors: *Eutrophication, *Thermal stratification, *Water quality control, *Mixing, Impoundments, Ohio, Lake morphometry, On-site data collections, Water temperature, Water properties, Pumping, Profiles.
Identifiers: Dissolved gases, Impoundment overturns, Destratification.

Mechanical pumping was used to eliminate thermal stratification in four lakes in southern Ohio during the summer of 1964. The lake volumes were 98, 100, 120, and 1260 acre-feet. Each impoundment was thermally and chemically stratified before pumping began. The equipment was a pontoon-mounted, axial-flow pump, 13 acre-foot/day capacity, driven by a gasoline engine. The pump drew water from the bottom and discharged it at the surface. Profiles of temperature, pH, and concentrations of dissolved oxygen and carbon dioxide were taken before and after pumping. Data presented show that this method was effective in destratifying these lakes. In addition, the data show that water quality was improved by artificial destratification and that an entire impoundment could be mixed with the pump located at a single position. Some data are presented on total work requirements, but these were dependent on the efficiency of the mechanical equipment and the percentage of cold water in the impoundment before pumping. (Auen-Wisconsin)
W70-05560

RESIDUES OF TWO HERBICIDES IN WATER IN IRRIGATION CANALS,
Bureau of Reclamation, Denver, Colo. Div. of Research; and Wyoming Agricultural Experiment Station, Laramie.
P. A. Frank, R. H. Hodgson, and R. D. Comes.
Weeds, Vol 15, No 4, p 353-355, October 1967. 2 tab, 3 ref.

Descriptors: *2-6-dichlobenil, *Herbicides, *Pesticide residues, *Aquatic weed control, *Irrigation canals, Irrigation water, Water conveyance, Water pollution, Water pollution sources, Weed control, Soil contamination, Toxicity, Persistence, Wyoming.
Identifiers: *2,3,6-trichlorophenylacetic acid, *Fenac, Plots.

Soil in irrigation canals is often treated by herbicides in order to control aquatic weeds. Irrigation water may be contaminated by subsequently flowing over the soil. Research was undertaken to study the persistence of 2,3,6-trichlorophenylacetic acid (fenac) and 2,6-dichlorobenzonitrile (dichlobenil) in irrigation water which had flowed over treated soils. The first water to cross the treated plots showed concentrations of 8.82 and 8.63 ppm concentrations of fenac and dichlobenil, respectively. The majority of the residue was quickly removed from the plots, with safe levels reached after one hour of water flow. Rapid reduction of herbicide concentration in water was possible when water was passed over areas of untreated canal soil. When this condition exists, or when it is possible to waste early water flows safely, disposal of the residues of the two herbicides is feasible. (Carr-Arizona)
W70-05599

AN ENGINEERING ECOMONIC STUDY OF THE INDUSTRIAL GROWTH POTENTIAL OF THE UPPER PASSAIC RIVER BASIN,
Stevens Inst. of Tech., Hoboken, N.J.
For primary bibliographic entry see Field 6B.
W70-05643

POTABLE WATER AVAILABILITY ON LONG OCEANIC ISLANDS,
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 02L.
W70-05646

WATER RESOURCES AND WATER POLLUTION IN THE ECOLOGY OF AN INDUSTRIALIZED COUNTRY,
Iowa Univ., Iowa City. Dept. of Microbiology.
J. R. Porter.
Biotechnology and Bioengineering Symposium, No 1, p 133-158, 1969. 9 fig, 3 tab, 24 ref.

Descriptors: *Water resources, *Water pollution control, *Water pollution sources, Water conservation, Sewage, Biochemical oxygen demand, Diseases, Reservoirs, Silting, Air pollution, Sedimentation, Water reuse, Water purification, Legislation, Silica, Carbon dioxide.
Identifiers: Hydrocarbons, N-oxides, Particulate matter.

This comprehensive report reviews the supply and demand for water in the USA, regional water resources, and current and projected uses of water. The conclusion is that drastic measures must soon be taken to conserve the available supply of water and to reduce the present level of pollution. The latter includes daily flows of sewage, detergents, fertilizers, acids, and pesticides. Fecal pollution adds an alarming variety of intestinal and other pathogenes affecting man and domestic animals. The deposition of eroded silt reduces annually the reservoir capacity of the US by 1.5 billion cubic yards. The recent threat is presented by discharges of radioactive substances from 18 nuclear power plants (about 80 in 1975). Thermal pollution, water renovation, watershed control, solid waste disposal, and air pollution are subjects of the report. (Wilde-Wisconsin)
W70-05665

TRACER AIDS INTERPRETATION OF PUMPING TEST,
Oak Ridge National Lab., Tenn.
Wallace De Laguna.
Water Resources Research, Vol 6, No 1, p 172-184, February 1970. 13 p, 8 fig, 2 tab, 7 ref.

Descriptors: *Groundwater movement, *Aquifers, *Pumping, *Withdrawal, *Water pollution control, Water levels, Water quality, Water level fluctuations, Transmissivity, Permeability, Alluvium, Water pollution treatment, Radioisotopes, Radioactive wastes, Hydrogeology, Nuclear power plants.
Identifiers: Pumping tests, Aquifer testing, Scavenging wells, Mol (Belgium).

The nuclear research center at Mol, Belgium, is underlain by clean quartz sand to a depth of about 30 meters. An accident at one of the nuclear facilities, which could contaminate the groundwater, would entail serious consequences. The upper Mol sand is somewhat coarser grained and therefore probably more permeable than the underlying Casterle sand. The lower part of the Mol sand contains a number of thin clay layers which make a partial hydrologic barrier between the two formations, dividing the water table aquifer into two parts. A test well was installed, screened through the full thickness of both sands, and test pumped. Drawdowns were measured in observation wells screened both in the Mol sand and in the Casterle sand. A tracer was added to four of the observation wells in turn, and the arrival of the tracer was measured in the pumped well. The average travel times in the Mol and Casterle sand were used to determine the amount of water being produced from each by the pumping, and these data, with the observed drawdowns, were used to calculate the transmissibility, the permeability, and the storage coefficient of each of the two formations. The designs of several well systems for pumping contaminated groundwater out of the aquifers are discussed. Pumping out the contaminated groundwater and decontaminating it appears to be a practical method of resolving some of the problems that would be raised by a nuclear accident in the Mol area. (Knapp-USGS)
W70-05678

A METHODOLOGY FOR SELECTING AMONG WATER QUALITY ALTERNATIVES,
Florida Univ., Gainesville. Dept. of Environmental Engineering; and North Carolina Univ., Chaper Hill. Dept. of City and Regional Planning.
Gilbert S. Nicolson, Edwin E. Pyatt, and David H. Moreau.
Water Resources Bulletin, Vol 6, No 1, p 23-33, January-February 1970. 11 p, 7 fig, 1 tab, 16 ref.

Descriptors: *Water quality, *Reservoir operation, Water temperature, Thermal stratification, Eutrophication, Waste treatment, Optimization, Systems analysis, Decision making, Dissolved oxygen, Low flow augmentation, Water quality control, Dynamic programming.
Identifiers: Savannah River (Ga).

While reservoirs are constructed to regulate stream flows for several beneficial purposes including flood control, water supply, hydroelectric power, irrigation and low flow augmentation and to enhance water based recreation, they also create problems of water quality. Among other potential deleterious effects, thermal stratification in reservoirs inhibits mixing and causes a deterioration of dissolved oxygen levels in lower layers. Schemes for alleviating detrimental effects are reviewed and a methodology for evaluating some of these alternatives in a river-reservoir system is outlined. (Knapp-USGS)
W70-05703

ECONOMIC CONSIDERATIONS RELATIVE TO WATER QUALITY,
Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.
William Whipple, Jr.
Water Resources Bulletin, Vol 6, No 1, p 34-42, January-February 1970. 9 p, 30 ref.

Descriptors: *Water quality control, Economics, *Planning, Water quality, Recreation, Water pollution control, Systems analysis, Cost-benefit analysis.

Our national water quality control program is on a wholly empirical basis. Not only has there been no effort to determine the benefits of water quality control, the theoretical groundwork for optimization has not been developed. Three main national objectives for consideration are national economic efficiency, preserving and improving the national environment for man's use and development (conservation), and regional development. Although popular at present, the regional development objective is not particularly useful from an economic viewpoint. Efficiency objectives other than environmental can be evaluated but are apt to be minor. Other water quality benefits can be broken down appropriately into 4 main categories: (a) man's recreational environment; (b) man's home environment; (c) man's working environment; (d) intangibles related to scientific, historic, health and cultural values. In management of water quality, various technical relationships must be considered, particularly as to quantity of water needed for waste disposal, and relationship of this use to water supply withdrawals. Advanced waste treatment must be compared with other alternatives, not only of flow augmentation, but also technological process changes, distribution of effluents, and artificial river aeration. (Knapp-USGS)
W70-05708

ECOLOGICAL STUDY OF BOLINAS LAGOON, MARIN COUNTY, CALIFORNIA,
Resources and Ecology Projects, Mill Valley, Calif.
For primary bibliographic entry see Field 02L.
W70-05713

SYSTEM ANALYSIS AND ITS APPLICATION TO RIVER BASIN POLLUTION CONTROL MANAGEMENT,
Jadavpur Univ., Calcutta (India). Dept. of Civil Engineering.
N. Chaudhuri.
Institution of Engineers (India) Journal, Public Health Eng Div, Vol 49, No 10. p 118-124, June 1969. 8 fig, 2 tab, 5 ref, 1 append.

Descriptors: *Systems analysis, *Linear programming, *River basins, *Water pollution control, Wastewater treatment, Optimization, Mathematical models, Cost, Water management (Applied).

The paper introduced the possibility of application of systems analysis as a tool for solving management problems of river pollution for an entire basin. The pollution control problem was shown as a linear programming model and the characteristics of its solution were illustrated graphically. A hypothetical river basin including locations of wastewater treatment plants was used as an example. The problem was to estimate an optimal combination of treatment efficiencies at two plants so that total cost of treatment was minimized and at the same time the minimum dissolved oxygen content was maintained in the river. For the numerical solution of the hypothetical river basin, the assumed value for various rate constants, distances, cost equation constants, plant discharges, BOD values of wastes coming to the plants, dissolved oxygen contents of effluent discharge and other values related to the river were given. (Kriss-Cornell)
W70-05769

MULTIPLE PURPOSE USE OF THERMAL CONDENSER DISCHARGES FROM LARGE NUCLEAR SYSTEMS TO SUPPLEMENT INTER-REGIONAL WATER SUPPLY,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
For primary bibliographic entry see Field 03D.
W70-05784

POLLUTION REDUCTION PROGRAM FOR THE TEXTILE INDUSTRY,
J. W. Masselli, and M. G. Burford.
Sewage and Industrial Wastes, Vol. 28, No. 10, p 1273-1293, 1956.

Descriptors: *Water pollution control, *Water pollution sources, Pollution abatement, Biochemical oxygen demand.
Identifiers: *Chemical substitution, *Process chemicals, *Textile mill wastes, Package treatment unit.

Report on New England Interstate Water Pollution Control Commission program on textile wastes to determine sources of pollution and possibility of using package treatment unit for them; considerable reduction in pollution may be obtained by substitution of low BOD for high BOD chemicals; process chemical inventory and BOD survey is aid in pin-pointing source of pollution. (Mattox and Livengood-North Carolina State Univ)
W70-05864

06. WATER RESOURCES PLANNING

6A. Techniques of Planning

REGIONAL GROWTH AND INTERREGIONAL CAPITAL MOBILITY (IN GERMAN),
Institut fuer Internationale Wirtschaftsbeziehungen, Munich (West Germany).
Franz Holzheo.
Kyklos, Vol 22, Fasc 3, p 417-453, 1969. 5 fig.

Descriptors: *Regions, *Capital, Capital mobility, Prices, Labor supply, Demand, Competition.
Identifiers: *Capital movements, Wealth, Regional growth, Neoclassical model, Factor mobility.

This paper shows that endogenous treatment of international capital movements should be an essential element in the analysis of regional development. Capital movements to or from a region are assumed to depend on the real prices of interregionally traded goods and on the supply of labor, technical progress, the development of the demand for goods, and the accumulation of wealth in that region. In this view, interregional capital movements are a permanent phenomenon of regional growth and therefore should not be considered in the analysis of regional growth by treating them as exogenous disturbances. The author uses a neoclassical model based on neoclassical models of interregional trade to present his views. By introducing assumptions on competition and factor mobility which are different from those typically used in neoclassical analysis, the author modifies the results and brings them nearer to reality. As such, this would be of interest to the water researcher investigating the effects of interregional water transfers and investments. (Loeb-Rutgers)
W70-05574

EXPERIMENTAL DETERMINATION OF RELATIVE MARGINAL UTILITIES,
Harvard Univ., Cambridge, Mass.
Koichi Mera.
Quarterly Journal of Economics, Vol LXXXIII, No 3, pp 464-477, August 1969. 3 fig, 1 tab, 1 append.

Descriptors: *Marginal utility, *Welfare, Social function, Income, Benefits, Costs, Taxes.
Identifiers: *Social welfare function.

It is common knowledge that the social welfare function cannot be defined unambiguously. However, public officials need some social welfare function, implicit or explicit, in order to formulate and administer policies and programs. What is required is not an abstract social welfare function that is applicable to any situation, but a specific function that describes the preference of the public as represented by legislators. Such a welfare function can be derived from decisions made by a public body if several assumptions are granted. In this paper the author attempts to identify a set of assumptions needed for deriving a welfare function by taking the U.S. Congress as an example, without claiming that this particular set of assumptions is the only plausible one. This type of analysis would have relevance to the water area where water projects enter into the social welfare function. (Loeb-Rutgers)
W70-05579

ELECTRIC POWER AND ECONOMIC DEVELOPMENT,
National Economic Research Associates, Washington, D.C.
Bruce C. Netschert.
The Economic Impact of TVA, Knoxville, University of Tennessee Press, 1967. pp 1-23, 23 p, 22 ref.

Descriptors: *Electric power, *Hydro power, *TVA, *Economic evaluation, Growth rate, Costs, Government, Capital, Price, Industrial production, Multipurpose projects, Natural resource development, Social aspects, Value, Income, Cost minimization.
Identifiers: *Economic development, Discontinuities, Standard of living.

This article concerns the role played by energy sources generally and electric power in particular in programs of economic development. The argument is advanced and documented that large-scale power development is not a panacea. This was not so in the case of TVA, and it is perhaps less likely to be the situation for other areas. The largest problem in hydropower is the discontinuous nature of the cost curves, necessitating large initial capital investment, thus ruling out private investors. This is partially alleviated by multipurpose projects. The author concludes that a preoccupation with the development of thermal and hydro generating stations in the early stages of economic development is not an efficient allocation of capital. (Murphy-Rutgers)
W70-05581

NATURAL RESOURCE PROBLEMS AND TVA,
Resources for the Future, Inc., Washington, D.C.
Joseph L. Fisher.
The Economic Impact of TVA, Knoxville, University of Tennessee Press, 1967, pp 41-55, 15 p, 7 ref.

Descriptors: *TVA, *Natural resource development, *Economic analysis, Population, Demand, Cities, Dams, Income, Recreation, Electrical power, Costs, Nuclear power, Flood control, Water supply, River basins, Unemployment, Regional analysis, Planning.
Identifiers: *Urban growth, *Standard of living, Subsistence farming, Anti-poverty program.

The author discusses the TVA in the context of the changing problems of natural resource availability and utilization which face the United States. The discussion involves the contribution that TVA has made toward a solution to some of these resource problems. The author analyzes the national economy and predicts the consequences of the changing economic environment on the demand for natural resources. In general, a regional approach to the solution of these problems can supply major contributions. The author further suggests that it would be interesting to see the development of more regional agencies patterned after the broad multipurpose format of TVA. (Murphy-Rutgers)
W70-05583

MODELING OF THE GREAT LAKES WATER SYSTEM,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 02H.
W70-05633

AN ENGINEERING ECOMONIC STUDY OF THE INDUSTRIAL GROWTH POTENTIAL OF THE UPPER PASSAIC RIVER BASIN,
Stevens Inst. of Tech., Hoboken, N.J.
For primary bibliographic entry see Field 6B.
W70-05643

THE TEMPORAL ALLOCATION OF GROUNDWATER - A SIMULATION APPROACH,
Geological Survey, Washington, D.C., and Resources for the Future, Inc., Washington, D.C.
John D. Bredehoeft, and Robert A. Young.
Water Resources Research, Vol 6, No 1, p 3-21, February 1970. 19 p, 17 fig, 32 ref.

Descriptors: *Water resources development, *Water allocation (Policy), *Water distribution (Applied), *Economics, *Groundwater basins, Groundwater, Groundwater movement, Planning, Withdrewal, Systems analysis, Water storage, Optimization, Forecasting, Mathematical models, Analog models, Simulation analysis, Water utilization.
Identifiers: Groundwater allocation.

Users of groundwater are typically interdependent in that withdrawals affect the conditions of water supply experienced by neighboring pumpers. In such cases all costs are not registered on the unit making the withdrawal decision, and the individual user of groundwater is encouraged to withdraw water at a rate faster than is socially optimal. Previous attempts to consider the problem of the optimal rate of pumping over time from a groundwater basin have used a simplified model for the groundwater system that assumes that drawdowns in response to withdrawals are uniformly distributed through the basin. However, large differences in drawdown commonly occur in developing groundwater systems. These differences throughout the basin lead to great variations in water costs and perhaps to localized economic and hydrologic failure. A more realistic groundwater model was used in a simulation program representing a groundwater basin system. The effects of two policy instruments (a use tax and a quota) were investigated for a hypothetical basin in an arid region in which irrigated farming was the principal economic activity. A policy of unrestricted use was compared with a policy of regulation for several alternative aquifer developments. Policies that reduced the rate of withdrawal increased the discounted net economic yield. (Knapp-USGS)
W70-05699

A TWO-STAGE OPTIMIZATION MODEL FOR DESIGN OF A MULTIPURPOSE RESERVOIR,
California Univ., Los Angeles; and Chile Univ., Santiago.
Fereidoun Mobasheri, and Ricardo C. Harboe.
Water Resources Research, Vol 6, No 1, p 22-31, February 1970. 10 p, 3 fig, 11 ref. OWRR Projects A-003-CAL and B-061-CAL.

Descriptors: *Reservoir design, *Multiple-purpose reservoirs, *Optimization, Systems analysis, Dynamic programming, Water resources development, Mathematical models, Synthetic hydrology, Computer programs.
Identifiers: Two-stage optimization models.

A mathematical model that can be useful in determining the optimum design and operation of a single multipurpose reservoir is presented. The development purposes include firm water supply, firm on-peak and dump hydropower production, flood control, and low flow augmentation. The model is based upon a two-stage optimization technique. It takes into account the fact that economic returns from a project are a function of both design and operational rules of the project. A dynamic programing algorithm which has a physical recursive equation computes the optimum operation policy of a feasible design. An iterative uniform grid sampling algorithm is then used to compare designs for which optimum operations are already determined and to select the best design. The model is applied to a hypothetical water resources project for illustrative purposes. The limitations of this mathematical model and some future research that may eliminate these limitations are discussed. (Knapp-USGS)
W70-05700

NONLINEAR PROGRAMING APPLIED TO REGIONAL WATER RESOURCE PLANNING,
Federal Water Pollution Control Administration, Washington, D.C.
George K. Young, and Mark A. Pisano.
Water Resources Research, Vol 6, No 1, p 32-42, February 1970. 11 p, 3 fig, 4 tab, 8 ref.

Descriptors: *Systems analysis, *Optimization, *Cost analysis, *Water resources development, *Decision making, Water supply, Desalination, Surface waters, Groundwater, Water reuse, Water demand, Forecasting, Water utilization.
Identifiers: *Sensitivity analysis, James River (Va), Nonlinear programming.

Methods of nonlinear programming are given for finding the least-cost mix of alternatives reservoirs, weather modification, wells, desalination, and treated waste water) to satisfy future water demands within a region. The analysis demonstrates that analytical techniques can be applied to the complex problem of water supply to make the planning process more meaningful. Decisions can be made with some degree of confidence that they will not be outdated before initiated. A sensitivity analysis is attempted in an effort to define the effect of future technology on the alternative sources of water, but because of the unpredictability of this factor, other approaches must be tried. (Knapp-USGS)
W70-05701

ROUTE OR CONVOLUTE,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
For primary bibliographic entry see Field 02A.
W70-05702

A METHODOLOGY FOR SELECTING AMONG WATER QUALITY ALTERNATIVES,
Florida Univ., Gainesville. Dept. of Environmental Engineering; and North Carolina Univ., Chaper Hill. Dept. of City and Regional Planning.
For primary bibliographic entry see Field 05G.
W70-05703

SPECIFICATIONS FOR A COMPUTER SIMULATION MODEL OF THE NATIONAL WATER DATA SYSTEM, PHASE A, FINAL SUMMARY REPORT,
Travelers Research Corp., Hartford, Conn.
Robert H. Ellis.
January 1967. 138 p, 41 fig, 3 tab.

Descriptors: *Computer programs, *Simulation analysis, *Mathematical models, *Water data system, United States.
Identifiers: Output, Input, Processing levels.

The concept and specifications were developed for a computer simulation model to be used as an analytical tool to evaluate the operational efficiency of existing and hypothetical water data information systems. The work was part of a program to develop a water data acquisition processing and dissemination system which best meets the needs of the United States water data users both within and outside the government. A description of the water data information system of the Water Resources Division of the Geological Survey, Department of the Interior was given. The types of data observed, processed and disseminated by many government agencies, were described and characteristics of each data type in terms of numerical model descriptors were indicated. Output of the simulation model together with appropriate application of the output for evaluation of water data systems was described. The report specified simulation model input requirements, model components, machine requirements and model scope. The system shown had four processing levels and it was determined that aggregation of detail at the observation processing level would permit simulation of the entire system within the constraints dictated by computer storage capacity. It was further shown that where the storage requirements of the entire hierarchy of processing levels comprising a proposed information system exceed computer capacity, one or more levels may be simulated separately and the results combined to provide information relevant to the whole system. (Kriss-Cornell)
W70-05768

SYSTEM ANALYSIS AND ITS APPLICATION TO RIVER BASIN POLLUTION CONTROL MANAGEMENT,
Jadavpur Univ., Calcutta (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 05G.
W70-05769

SEVERAL DYNAMIC PROGRAMMING ALGORITHMS AND THEIR APPLICATION TO A DAM PROBLEM,
California Univ., Berkeley. Operations Research Center.
Marc H. Blanc.
NSF Grant GK-1684. ORC 69-40, Dec 1969. 28 p, 1 fig, 1 tab, 4 ref, 1 append.

Descriptors: *Dynamic programming, *Optimization, *Mathematical models, Hydro-electric plants, Variability.
Identifiers: Shasta Dam, Algorithm, Data arrays, Graphs.

A comparative study of three dynamic programming algorithms was made. These included: (1) Standard dynamic programming; (2) Incremental dynamic programming; and (3) Incremental dynamic programming with approximation. Optimization of the scheduling of complex hydro-electric systems was studied. First, the formulation in mathematical terms of the corresponding control problems and the description of the algorithms were given. Then the models were applied to the regulation of the Shasta Dam. The problem was solved by each of the three methods, including a cross testing of the procedure and several changes of parameters. The results were displayed in data arrays and by graphs. A variational method that combined features of a dynamic programming algorithm and a gradient procedure was introduced in the appendix. (Kriss-Cornell)
W70-05770

AN ALTERNATIVE PROCEDURE FOR THE OPTIMIZATION OF OPERATIONS FOR

PLANNING WITH MULTIPLE RIVER MULTIPLE PURPOSE SYSTEMS,
California Univ., Los Angeles.
Warren A. Hall, G. W. Tauxe, and W. W-G. Yeh.
Water Resources Research, Vol 5, No 6, p 1367-1372, Dec 1969. 3 ref.

Descriptors: *Optimization, *Planning, *Multiple purpose projects, *River systems, Dynamic programming, Linear programming, Constraints, Time.
Identifiers: Modified gradient procedure, Monte Carlo analysis.

A technique was developed for maximizing the financial feasibility of a complex, multiple river water resources system for planning purposes, based on deliveries of firm power, in-season water, dump power, and off-season water, with flood control and releases for non-commensurate objectives as parameters. The method was an important modification of a previously reported analysis developed by Parikh involving dynamic programming, linear programming, and modified gradient procedure, replacing the computationally inefficient linear programming determination of the shadow prices by a standard sequence of constraints. Total computation time was reduced from hours to minutes. (Kriss-Cornell)
W70-05776

SIMULATION OF STREAMFLOW IN SCOTLAND,
University of Strathclyde, Glasgow (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 02E.
W70-05899

RISKS IN HYDROLOGIC DESIGN OF ENGINEERING PROJECTS,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 08B.
W70-05905

6B. Evaluation Process

PLANNING TECHNIQUES FOR REGIONAL DEVELOPMENT POLICY,
Maryland Univ., College Park.
Curtis C. Harris, and Martin C. McGuire.
Journal of Human Resources Vol IV, No 4, p 466-490, Fall 1969. 25 p, 6 tab, 2 fig.

Descriptors: *Regional analysis, *Economic evaluation, *Population, *Forecasting, *Employment, *Unemployment, Migration, Growth rates, Welfare economics, Budgeting, Gross National Product, Capital, Model studies, Least-squares regression, Cities, Social mobility, Distribution patterns.
Identifiers: Sensitivity analysis, Time trends, Econometrics, Job creation.

One aspect in applied welfare studies concerns the interaction between the growth of national economies and the constituent subeconomies of which the national economies are comprised. At present, the fundamental issues for public policy consideration are the questions of what constitutes an appropriate regional distribution of economic activity. This paper seeks to develop techniques for the projection and analysis of the distribution of economic progress among the counties in the United States. The paper describes the alternative regional projections of employment and income; the alternative population projections for comparable regions; and the comparisons of labor force availabilities and demands for labor by region. The paper points to the importance of national migration policy in the future and the very high unemployment expected in urban centers by 1975. The importance of regional development and planning in determining water resource needs, projections and subsequent policy makes this article of interest to studies of regional water planning. (Murphy-Rutgers)
W70-05570

DYNAMIC PROGRAMING FOR THE OPTIMAL SEQUENCING OF WATER SUPPLY PROJECTS,
Nevada Bureau of Mines, Reno. Desert Research Inst.; California Univ., Los Angeles; and California Univ., Riverside.
William S. Butcher, Yacov Y. Haimes, and Warren A. Hall.
Water Resources Research, Vol 5, No 6, p 1196-1204, December 1969. 3 fig, 5 tab, 3 ref.

Descriptors: *Dynamic programming, Water supply, Costs, Investment, Demand, Interest rate, Time, Planning.
Identifiers: *Optimal sequencing, *Water supply projects, Water projects, Present cost.

This article derives minimum present cost strategy for investment in water projects. An increase in demand for water is considered to be supplied by a number of projects that have an indefinite life. The optimum sequence of installation of these projects is determined by (1) the shape of the water demand/time relationship, (2) the appropriate interest rate, and (3) the relative costs and capacities of the facilities from which a selection is made. A general method to derive the optimum sequence of construction is developed using dynamic programing. Examples of the use of the technique are given. (Loeb-Rutgers)
W70-05571

MARGINAL VALUES OF DILUTION WATERS,
Washington Univ., Seattle.
Lavere B. Merritt, and Brian W. Mar.
Water Resources Research, Vol 5, No 6, p 1186-1195, December 1969. 4 fig, 3 tab, 15 ref, 1 append.

Descriptors: *Water resources, Waste dilution, Economics, Waste water, Costs, Marginal costs, Waste treatment, Biochemical oxygen demand.
Identifiers: *Marginal value, *Dilution waters, Willamette River Basin.

For the allocation of a water resource to be based on economic criteria, the marginal values of water used for alternative purposes must be determined. In this paper, an order of magnitude estimate is presented of the marginal value of water used for dilution of treated or untreated waste waters. Such information should be of interest to an exporter of water in evaluating the increased cost of water quality control owing to receiving water flow reduction as well as to an importer of water who anticipates a reduction of water quality control costs (other than the cost of dilution water) owing to flow increase. It is assumed in this study that waste dilution and treatment are complementary methods of waste disposal to satisfy the constraint on waste loading defined by water quality standards or effluent charges. (Loeb-Rutgers)
W70-05572

WATER RECREATION, DEMAND, AND SUPPLY,
Rutgers - The State Univ., New Brunswick, N.J.
Joseph J. Seneca.
Water Resources Research, Vol 5, No 6, p 1179-1185, December 1969. 13 ref.

Descriptors: *Demand, *Supply, Water resources, Time series analysis, Cost-benefit analysis, Planning, Recreation, Statistical methods.
Identifiers: *Water recreation, Cross section data, Polling technique, Rates of use, National Recreation Survey, Tennessee Valley lakes.

This paper discusses the problems involved in identifying valid demand and supply parameters estimated from sample data on recreation. It is argued that an analysis of cross section data permits the quantification of the effects of demand variables. Cross section results can then be pooled with recreation time series to enable the valid estimation of supply parameters. These supply parameters can be used to improve decisions regarding the expansion and development of recreation sites. More refined projections of rates of use can be derived for use as benefit measures in cost-benefit analysis. An example of the pooling technique is presented using demand equations estimated from the National Recreation Surveys and a time series of visitation data at the Tennessee Valley lakes. The results tend to confirm the superiority of the method proposed, particularly in comparison with an analysis using only time series data. (Loeb-Rutgers)
W70-05573

STOCK-FLOW DECISIONS AND FULL EQUILIBRIUM,
Paris Univ. (France); and Cologne Univ. (West Germany).
Emil M. Claassen.
Kyklos, Vol 22, Fasc 3, p 493-504, 1969. 2 fig, 9 ref, 1 append.

Descriptors: *Flow, Planning, Decision making, Equilibrium.
Identifiers: *Savings, *Assets, *Stocks, Utility maximization, Planning horizon, Hicksian concepts.

The study is concerned with the optimum saving-assets position of an individual. This optimum position is the outcome of simultaneous utility maximization with respect both to intertemporal consumption flows and to stocks of more than one type of asset. The optimal conditions of these stock-flow-decisions are stated in the form of a model based on the assumptions that the individual has a multiperiod planning horizon, and that he is confronted with two types of assets. This stock-flow equilibrium is examined for: (1) a single period and (2) for a whole series of periods. Using the Hicksian concepts, revived by Archibald and Lipsey, the author speaks, in the first case, of weekly equilibrium, and in the second, of full equilibrium meaning that the individual reaches, after a series of weeks, the invariance over time of his desired stock of assets. This article may also be regarded as an attempt to fill the lacunae in the graphical presentation of Patinkin's 'Utility Theory of Money, Assets, and Savings' (Money, Interest, and Prices, 2nd ed). This article may prove applicable to the water researcher in the area of water investment and planning. (Loeb-Rutgers)
W70-05575

USER RESPONSE IN OUTDOOR RECREATION: A PRODUCTION ANALYSIS,
Rutgers - The State Univ., New Brunswick, N.J.; and Resources for the Future, Inc., Washington, D.C.
Joseph J. Seneca, and Charles J. Cicchetti.
Journal of Leisure Research, Vol 1, No 3, p 238-245, Summer 1969. 2 fig, 1 tab, 6 ref.

Descriptors: *Recreation, *Supply, *Recreation demand, Recreation facilities, Demand, Model studies, Forecasting, Statistical methods, Economic predictions, Swimming, Boating, Fishing, Land, Water supply.
Identifiers: *User response function, *Production analysis, Appalachian Region, Recreation use, Recreation visits, Identification problem, Econometrics, Economic model, Empirical estimation, User day projections, Land acres, Parking places, Water acres.

This study attempts to identify the influence of production-type variables on outdoor recreation activity. A large amount of previous recreation research has been concerned with estimating recreation 'demand.' In this paper, it is argued that there are inherent problems in estimating recreation 'demand' that often lead to erroneous policy conclusions. Part of this confusion is due to neglect in evaluating the influence on recreation activity of the supply or production side of the recreation market. Cross-section data of recreation sites in the Appalachian Region was used to estimate the rela-

tion between the extent of recreation use and various physical indices of the recreation site. The result is a user response function that establishes a quantitative relation between the physical facilities of the recreation site and the quantity of recreation visits occurring there. This relation can be used to simulate various recreation policy alternatives and obtain quantitative indications of the number of recreation visits that could be accommodated by the postulated supply of facilities without altering the quality of the recreation visits implicit in the user response function. An empirical example of projecting recreation user response to proposed facility increases in a subregion of the Appalachian area is presented. The close relation of water resources and water quality to outdoor recreation make this article relevant to the water study area. (Loeb-Rutgers)
W70-05576

BENEFIT-COST RATIOS FOR PROJECTS IN MULTIPLE OBJECTIVE INVESTMENT PROGRAMS,
Massachusetts Inst. of Tech., Cambridge.
David C. Major.
Water Resources Research, Vol 5, No 6, p 1174-1178, December 1969. 1 fig, 12 ref.

Descriptors: *Cost-benefit ratio, *Investment, Water resources, Income, Planning.
Identifiers: *Multiple objectives, Social preferences, Regional development.

Investment programming for multiple objectives has become an important new element of water resources planning in the United States. In addition to the traditional water resource planning objective of increasing the national income, explicit statements of planning objectives now include goals such as regional development and improvement of the quality of the environment. A question that naturally arises when projects in multiple objective programs are considered is the composition of the benefit-cost ratios appropriate to them. The question of developing appropriate benefit-cost ratios for multiple objective projects has been complicated for the water resource agencies because, as is shown in this paper, the current federal instructions for formulating such ratios do not permit the agencies to reflect the interaction of social preferences and investment opportunities in an accurate manner. The purposes of this paper are to demonstrate how the formula for the benefit-cost ratio of a multiple objective project is derived from the theory of multiple objective public investment; to indicate how this formula differs from the guidance offered in the current federal instructions; and to recommend that these instructions be broadened to permit the water resource agencies to use the appropriate formula for benefit-cost ratios of multiple objective projects. (Loeb-Rutgers)
W70-05577

COOPERATIVE CITY-COUNTY RATE STRUCTURES,
Baltimore County, Md.; and Burns and Roe, Inc., Oradell, N.J.
William A. Badger, and John L. Rose.
Journal of the American Water Works Association, Vol 61, No 11, p 581-584, November 1969. 2 fig, 3 tab, 5 ref.

Descriptors: *Cities, Consumptive use, Rates, Water supply, Population.
Identifiers: *County, *Rate structure, Baltimore, Fiscal responsibility.

One of the most pressing problems of urban affairs is the effect of the population exodus from the core city and the growing demands for governmental services in the suburban-metropolitan area. Little attention has been devoted to the impact of this phenomenon on the provision of adequate water supply. The author illustrates the problem using the Baltimore metropolitan region as an example. Since World War Two, Baltimore County has experienced a large population growth while the city of Baltimore has grown only slowly. The increase in population has been accompanied by a commensurate increase in water consumption. Initially, the city has acted as a surveyor of water to suburban areas and as a banker for financing improvements to the water system. The declining population trend, eroding tax base, and increasing level of expenditures required to maintain service in the suburbs has resulted in a change in the relationship between city and county. This paper discusses the challenge to finance facilities necessary to provide service through equitable allocation of costs while maintaining reasonable rate structures. (Loeb-Rutgers)
W70-05578

THE APPLICATION OF TVA EXPERIENCE TO UNDERDEVELOPED COUNTRIES,
Development and Resources Corp.
John Oliver.
In The Economic Impact of TVA, Knoxville, University of Tennessee Press, 1967, p 26-40, 14 p, 2 ref.

Descriptors: *TVA, *Economic analysis, Technology, Planning, Capital, Financing, Multipurpose projects, Dams, Management, Government, Population, Regional analysis, Irrigation, Electric power, Agriculture, Investment.
Identifiers: *Economic development, *Columbia, *Iran, International finance, Standard of living.

This paper evaluates the applicability of the TVA experience to the underdeveloped areas. The author argues that the uniqueness of TVA is the basic concept and philosophy of the program, not the details of its operating procedures or its approaches to the solution of specific or isolated problems. After pointing out the important philosophical and organizational attributes which a TVA counterpart in an underdeveloped area must have and the difficulties which might be encountered in establishing these prerequisites, the author gives two case studies showing problems and procedures involved in establishing development agencies modeled after TVA: the Cauca Valley Corporation in Columbia and the Khuzistan Water and Power Authority in Iran. The economics of the water projects are evaluated and their economic effects discussed. (Murphy-Rutgers)
W70-05582

IDENTICAL PRICING AND TVA: TOWARD MORE EFFECTIVE COMPETITION,
Tennessee Univ., Knoxville.
Ronald H. Wolf.
In The Economic Impact of TVA, Knoxville, University of Tennessee Press, 1967, p 81-104, 24 p.

Descriptors: *Competition, *TVA, *Prices, Economic analysis, Government, Electric power, Bids, Cost analysis, Contracts, Economic evaluation, Legal aspects, Benefits, Supply.
Identifiers: *Antitrust, *Identical bids, *Collusion, Price-fixing, F.O.B. pricing.

This paper looks at the recent role of TVA in promoting competition in the private sector of the economy. The author gives a detailed examination of activities of TVA in exposing the bid-rigging which involved many major producers of electrical equipment who were supposedly selling to the agency on a competitive-bid basis. The TVA has often received identical bid prices which may result from competition but more often from concerted action on the part of rivals to act together on price, or from discrimination in absorbing freight in the case of some customers in order to achieve equality. Benefits arising from the prosecution of the identical bidders are discussed. The author evaluates the weaknesses in contemporary antitrust policy and makes suggestions for improvement. Since government agencies, water utilities included, are possibly subject to the same collusive practices, this article should be of interest to the water researcher. (Murphy-Rutgers)
W70-05584

A NOTE ON THE EQUIVALENT RISK CLASS ASSUMPTION,
Minnesota Univ., Minneapolis.
Ronald F. Wippern.
The Engineering Economist Vol 11, No 3, p 13-22, Spring 1966. 10 p, 2 tab.

Descriptors: *Risks, *Statistics, *Profits, Capital, Costs, Financing, Economics, Growth rates, Financial analysis, Economic evaluation, Sampling, Probability.
Identifiers: *Statistical analysis, *Analysis of variance, Profit variability, Per share earnings.

The assumption that firms within the same industry are subject to equivalent degrees of basic uncertainty is widely employed in financial theory and underlies many of the approaches to valuation. The purpose of this paper is to examine the validity of the risk-equivalency assumption and subject this assumption to statistical analysis. A sample of eight industries was selected in order to achieve a high degree of heterogeneity among industry characteristics and sixty-one firms within the industries were included. The validity of the assumption was tested by an analysis of variances to determine whether the net operating income per share variability measures differ significantly among industry groups. It was found that the homogeneity of business uncertainty is not achieved by confining samples to single industries. Since risk is an important factor in many water resource investments this article should be of interest to individuals concerned with the cost of financing public water expenditures. (Murphy-Rutgers)
W70-05585

WHICH DOLLARS--WHOSE UTILITY FUNCTIONS,
Massachusetts Inst. of Tech., Cambridge.
George E. Klein.
The Engineering Economist, Vol 12, No 2, p 107-116, Winter 1967. 1 fig.

Descriptors: Income, Costs, Decision making, Risks, Time, Management.
Identifiers: *Utility function, Incremental analysis, Stability.

There are still some phases of utility theory that require further thought. The author identifies two of the remaining problems and offers some tentative suggestions for their solution. The main focus of attention will be on which dollars and whose utility to use. The author contends that we should consider only the distribution of the net result for a project. Each possible level of revenue less its related cost is the appropriate measure. All projects over all future time should be considered together and it is the incremental contribution of a project to the utility of this grand total that bears the appropriate information upon how to make decision. On this issue of whose utility function should be used for a large organization, the answer is less clear but it seems that no one utility function is suitable. A point of view has been developed which indicates it is management's responsibility to purposively choose a pseudo-utility function for the firm, taking a position which it can sell to the other members of the coalition. This article may prove helpful to the water resource planner involved with managerial decisions. (Loeb-Rutgers)
W70-05586

ENVIRONMENTAL QUALITY IN A GROWING ECONOMY,
Resources for the Future, Inc., Washington, D.C.
Henry Jarrett.
Baltimore, Maryland, Johns Hopkins Press, 1966, 173p.

Descriptors: *Pollution, *Economic analysis, *Natural resources, Welfare economics, Cost-benefit analysis, Resource allocation, Income, Conservation, Prices, Wells, Rivers, Flood control, Federal government, Marketing, Social aspects, Environmental effects, Wastes, Fisheries, Water pollution, Pesticides, City planning, Industrial production.

Identifiers: *Environmental management, *Economic development, Chemical pollution.

This book contains a selection of essays originally presented at the Sixth Resources for the Future Forum on March 8 and 9, 1966. In the first two essays an inquiry is made into how natural resource development has and will affect the environment. The second pair of essays deals with the effects of environment upon human health, both physical and mental. The problems and possibilities of the fact that many of the economic problems of environmental quality are caused or aggravated by conditions lying outside the market economy is examined. The fourth set of essays examines the current state of economic research into the problems of the environment. The formation and evaluation of the public attitude towards environmental development is examined. The tasks and effects of all levels of government is studied in the last set of essays. Although the article is concerned with all aspects of environmental conservation, this book provides valuable insights for the water resource planner interested in the general problems of environmental quality. (Murphy-Rutgers)
W70-05587

MULTIPURPOSE BENEFITS AND COSTS OF MODIFYING PLAYA LAKES OF THE TEXAS HIGH PLAINS,
Texas Technological Coll., Lubbock. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 03B.
W70-05589

EMPIRICAL ANALYSIS OF THE DEMAND FOR WATER BY ISRAELI AGRICULTURE,
Hebrew Univ., Jerusalem (Israel).
Dan Yaron.
Journal of Farm Economics Vol 49, No 1, Part 1, p 461-473, February 1967. 2 fig, 1 tab, 20 ref.

Descriptors: *Water demand, *Economics, *Water resources, *Water allocation (Policy), *Model studies, Regional analysis, Resource allocation, Irrigation water, Irrigation, Agriculture, Economic impact, Equations, Farms, Crop production, Analytical techniques, Political aspects, Social impact.
Identifiers: *Israel, *Empirical analysis, *Demand function for water, Factors of production.

The paper presents an approach used to analyze water demand in Israeli agriculture. The heart of the analysis was a country-wide aggregative programing model which was used to derive the marginal segment of the demand function for water. This was used as a basis for evaluating overall demand function. It was a central thesis of the approach that in analyzing complex problems of agricultural water resources irrigation water should be treated as just another production factor in the agricultural production process. Results of the study indicate that the shape of the demand function for water depends to a great degree on the sociopolitical economic mix. This mix determines the framework within which the demand function is derived. Water allocation efficiency has a particularly strong influence on the demand function. Thus the more realistic the agricultural development program data used to derive the agricultural demand function for water, the more realistic the estimate of the function will be. (Carr-Arizona)
W70-05600

A STUDY OF INSTITUTIONAL FACTORS AFFECTING WATER RESOURCE DEVELOPMENT IN THE LOWER RIO GRANDE VALLEY, TEXAS,
Texas A and M Univ., College Station. Water Resources Inst.
Thomas J. Casbeer, and Warren L. Trock.
Available from the Clearinghouse as PB-191 063, $3.00 in paper copy, $0.65 in microfiche. Technical Report No 21, Water Resources Institute, Texas A and M University, September, 1969. 160 p, 6 tab, 84 ref, 3 append. OWRR Project B-025-TEX.

Descriptors: *Institutions, *Efficient resource use, *Water rights, *Irrigation, Drainage, Special districts, Rehabilitation, *Water resources development, Texas.
Identifiers: Rio Grande Valley.

Among the institutional factors which complicate water development and use in the Valley are: (1) a proliferation of special districts, (2) inappropriate water management policies among districts, (3) uncertainties in water rights, and (4) numerous governmental entities involved in planning for and administration of water resources. In the Valley, these factors have acted as deterrents to many needed developments and to changes in uses which would be economic. It is recommended that the people of the Valley request an early adjudication of rights. Certainty in the water rights will contribute to decisions to invest in the resource. Negotiability of rights is also suggested. This would require a change in State law, but it would facilitate achievement of efficiency in use of water in the Valley. Rehabilitation of irrigation systems, including installation of water meters is a needed further development. To achieve improvements in irrigation, flood control and drainage, some reorganization of people in special districts will probably be necessary. A master district for the three-county area may be a logical alternative to the many that now exist.
W70-05641

AN ENGINEERING ECOMONIC STUDY OF THE INDUSTRIAL GROWTH POTENTIAL OF THE UPPER PASSAIC RIVER BASIN,
Stevens Inst. of Tech., Hoboken, N.J.
Arthur Lesser, Jr., A. H. Spinner, and M. A. Tirabassi.
Available from the Clearinghouse as PB-191 065, $3.00 in paper copy, $0.65 in microfiche. Economics of Engineering and Management Science Dept., Stevens Institute of Technology. OWRR Projects B-009-NJ and B-017-NJ.

Descriptors: *Systems analysis, *Water quality, *Water pollution control, Simulation analysis, Industries, Industrial wastes.
Identifiers: Water quality parameters, Industrial growth potential, Industrial growth patterns.

The report covers research as to water quality and industrial growth on the upper Passaic River. Data over a period of years were obtained, including both parameters of water quality and profiles of industrial waste characteristics. Data were related by statistical analysis rather than by causal biological and chemical relationships; the method used was step-wise linear multiple correlation. These results were used with actual local data as to occurrence of industry, and effluent characteristics determined from the literature. The resulting model can be used to relate possible specific changes in industrial growth to future water quality on the river. Economic inferences as to preferential growth patterns are derived. (Whipple-Rutgers)
W70-05643

NONLINEAR PROGRAMING APPLIED TO REGIONAL WATER RESOURCE PLANNING,
Federal Water Pollution Control Administration, Washington, D.C.
For primary bibliographic entry see Field 06A.
W70-05701

PROPOSAL FOR A U.S. NATIONAL WATER ATLAS,
National Research Council, Washington, D.C. Committee for the International Hydrological Decade.
For primary bibliographic entry see Field 07C.
W70-05707

ECONOMIC CONSIDERATIONS RELATIVE TO WATER QUALITY,
Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.
For primary bibliographic entry see Field 05G.
W70-05708

JAMES RIVER BASIN COMPREHENSIVE WATER RESOURCES PLAN, VOLUME I -- INTRODUCTION.
Virginia Dept. of Conservation and Economic Development, Richmond. Div. of Water Resources.

Virginia Division of Water Resources Planning Bulletin 213, Vol I, March 1969. 193 p, 36 plate, 10 tab, 59 ref.

Descriptors: *Water resources development, *Planning, *Virginia, Hydrogeology, Rivers, Economics, Water requirements, Water supply, Water quality, Streamflow, Water yield, Water management (Applied), Data collections, Hydrologic data.
Identifiers: James River (Va).

The James River basin of Virginia extends from Hampton Roads on the east to the Virginia-West Virginia boundary on the west. It is the largest of the Virginia river basins, embracing one-fourth of the State's total area and is the home of more than two million people. The purpose of this study by the Virginia Division of Water Resources for the Board of Conservation and Economic Development is to examine the James River basin in light of its latest growth, to project the economy of the area to the year 2020, and to determine the quantitative water needs of the area for the future as well as for the present. Volume I is an introduction containing basic inventory data and descriptive material. The inventory includes: names of industrial and public water users and the latest available information on quantity of water withdrawn; listing of waste discharges and quantity of waste discharge; listing of current recreational development by type of activity; inventory of basin geology and estimates of current available groundwater; and current electric generating plant and major transmission facilities. (Knapp-USGS)
W70-05724

A NATIONAL ESTIMATE OF PUBLIC AND INDUSTRIAL HEAT REJECTION REQUIREMENTS BY DECADES THROUGH THE YEAR 2000 A.D.,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
R. T. Jaske, J. F. Fletcher, and K. R. Wise.
67th National Meeting of the AIChE, Atlanta, Paper No. 37A, February 17, 1970, 23p, 9 fig, 3 tab, 10 ref.

Descriptors: *Population, Cooling towers, Temperature, Industrial plants, Solar radiations, Forecasting, Transportation, Electric power production.
Identifiers: *Heat rejection, *Energy consumption.

Population estimates are made and per capita energy use is projected. During the next 30 years an overall doubling of the gross consumption and release of energy per capita is projected, while the electrical energy consumption on the same basis is projected to increase by a factor of 5.2. This growth will occur primarily in the use of electricity to replace traditional heat sources in the conversion industries and for space heating. Despite the remarkable reduction in the heat requirements for the production of steel using the basic oxygen process and other projected new reduction processes, total energy use by industry is expected to increase about twice as fast as factors directly related to population. It is projected that total energy release to environment will exceed 190,000 trillion Btu per year by the year 2000. Release rates in the Boston-Washington metropolis is projected to exceed 30% of the incident annual solar energy by the same year. Electrical consumption of a single new building in New York will exceed 80,000 kilowatts. If the total national energy requirement from 1970-2000 had to be served by direct evaporation devices such as cooling towers, the incremental

electrical capacity of 1,040 GW requires a consumptive flow of 31,200 cfs of water for evaporation alone. This sums to a total of approximately 24,000,000 acre ft. a year, about twice the flow of the entire Colorado river. (Upadhyaya-Vanderbilt)
W70-05787

ALTERNATIVE METHODS OF FINANCING WASTE TREATMENT FACILITIES,
Union Securities and Co., New York.
For primary bibliographic entry see Field 05D.
W70-05804

COMPARISON OF DETERMINATION OF ORGANIC COMPOUNDS IN RETTING WASTE WATERS BY CHEMICAL AND BIOCHEMICAL OXYGEN DEMAND METHODS (IN POLISH),
For primary bibliographic entry see Field 5A.
W70-05873

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

SOCIAL COSTS OF BUSINESS ENTERPRISE,
K. W. Kapp.
In Controlling Pollution: The Economics of a Cleaner America, Englewood Cliffs, Prentice-Hall, 1967, p 82-90, 9 p.

Descriptors: *Water pollution, *Cost-benefit analysis, *Pollution abatement, *Water resources, *Ecology, *Economics, Taxes, Management, Water supply, Air pollution, Environment, Recreation, Investment, Health, Topography.
Identifiers: *Social costs, *Social ecology, *External diseconomies, *Cumulative causation, Economic losses.

This article is concerned with the social costs of business enterprise. A social cost is defined if it: (1) is possible to avoid; (2) part of the course of productive activities; and (3) shifted to third persons or the community at large. Much of water pollution can be traced to productive activities and is man-made, avoidable and effects individuals other than the producers. The economic factors operating in a private enterprise economy increase the probability of incurring social costs. The author suggests a standard of social minima where social costs would be measured in terms of deficiencies from this minima. The social cost aspect of water pollution is well known and the author discusses the role of cost-benefit analysis in the evaluation process. (Murphy-Rutgers)
W70-05580

TRANSFER RESTRICTIONS AND MISALLOCATIONS OF IRRIGATION WATER,
Utah State Univ., Logan. Dept. of Agricultural Economics, and Iowa State Univ., Ames. Dept. of Economics.
For primary bibliographic entry see Field 03F.
W70-05605

AN ALTERNATIVE PROCEDURE FOR THE OPTIMIZATION OF OPERATIONS FOR PLANNING WITH MULTIPLE RIVER MULTIPLE PURPOSE SYSTEMS,
California Univ., Los Angeles.
For primary bibliographic entry see Field 06A.
W70-05776

THIRD CLASS CITIES (SEWER CONSTRUCTION-COSTS).

Mo Ann Stat secs 88.597 thru 88.600 (1952).

Descriptors: *Missoure, *Cities, *Sewers, *Construction costs, Legal aspects, Legislation, Assessments, City planning. Engineering structures, Sewage, Sewage disposal, Sanitary engineering, Construction, Utilities, Taxes, Laterals.

Special tax bills pay for sewer construction costs, including the erection of all necessary disposal plants. Third class cities may by ordinance cause the construction of sewers, including disposal plants, in or for any sewer district. Any sewer may by ordinance be changed, diminished, enlarged or extended and shall have all the necessary laterals, inlets and other appurtenances which may be required. The computation of costs for tax bills is regulated. Third class cities are not liable for the cost of constructing, changing, diminishing, enlarging or extending any sewer, or the cost of erecting any disposal plant. (Powell-Florida)
W70-05824

6D. Water Demand

COOPERATIVE CITY-COUNTY RATE STRUCTURES,
Baltimore County, Md.; and Burns and Roe, Inc., Oradell, N.J.
For primary bibliographic entry see Field 06B.
W70-05578

WATER AND THE SOUTHWEST,
Virlis Fischer.
American Forests, Vol 73, No 11, p 14-17, 71-73, November 1967. Map.

Descriptors: *Arid lands, *Southwest U.S., *Water shortage, *Water supply, *Water demand, Arizona, California, Nevada, Semiarid climates, Overdraft, Groundwater mining, Groundwater, Water utilization, Water conservation, Irrigation water, Recreation demand, Municipal water, Industrial water, Human population, Water pollution, Desalination, Inter-basin transfers, Colorado River, Colorado River basin, Colorado River compact.
Identifiers: Central Arizona Project, North American Water and Power Alliance (NAWAPA).

Water has always been the major resource problem in the arid Southwest, but water experts warn that the area is now facing the greatest water crisis in the history of the United States. Basically, the water shortage is due to population, pollution, and progressively increasing demands caused by the American standard of living. Present water supplies are not even adequate to maintain the currently existing level of development in the Southwest and the Colorado River is already overcommitted. The situation obviously is serious when the groundwater overdraft in the Gila River basin of Arizona is 2,200,000 acre-feet per year. Although national and international schemes (such as the North American Water and Power Alliance) have been put forward as possible answers to the water supply question, it appears that the regional approach is the most useful at the present time. Within this approach more efficient use of presently-existing water supplies is necessary, but it seems that the regional water shortage will be solved only by desalination of salt water or by importation of water from other areas. (Carr-Arizona)
W70-05609

NONLINEAR PROGRAMING APPLIED TO REGIONAL WATER RESOURCE PLANNING,
Federal Water Pollution Control Administration, Washington, D.C.
For primary bibliographic entry see Field 06A.
W70-05701

WATER FOR THE DYER,
T. H. Morton.
Journal of the Society of Dyers and Colourists, Vol. 83, No. 5, p 177-184, 1967.

Descriptors: *Water supply, *Waste water disposal, *Water quality, *Waste water treatment, Surface runoff, Legislation, Surfactants, Alkylbenzene-sulfonate.
Identifiers: *Textile mill wastes, *Dyehouse wastes, Wool grease, Dyestuffs, Dyehouse wastes.

The dye industry of England and Wales uses approximately 10% of the annual surface water runoff. Increasing use, uneven distribution, and water management problems are discussed in terms of the dyeworks water supply and effluent disposal. Water quality required and processes used to produce satisfactory waters for the dyeworks are discussed in relation to surface, impounded or subsurface supplies. Effluent disposal for dyehouse waste waters are under control of local or river authority by prearrangement. Dilution in municipal waste waters may simplify treatment where biological processes are acceptable. On-site treatment is likely to be more complex. Certain surfactants, dyes, and auxiliary agents may correspond to alkylbenzensulfonate in treatability. Process modification to provide effluents more ameanable to treatment includes substitution of dyes with more favorable color removal, recovery of grease and fatty acid, and reselection of surfactants and auxiliary agents. These alterations increase costs but are essential under present and anticipated conditions. (Mattox and Livengood-North Carolina State University)
W70-05871

6E. Water Law and Institutions

A FEDERAL VIEW OF WATER POLLUTION CONTROL,
Federal Water Pollution Control Administration, Washington, D.C.
William F. Keating.
Environmental Control Management, Vol 138, No 5, p 19-40, November 1969.

Descriptors: *Laws, Social aspects, Federal jurisdiction, State jurisdiction, Water pollution control, Water pollution sources, Water Quality Act, Water quality control, Cost sharing, Financing, Technological feasibility.

An interview with the Commissioner of the Federal Water Pollution Control Administration of the US Department of the Interior, reveals that inadequately treated municipal sewage and industrial wastes are the major sources of pollution. Federal legislation has provided funds to construct waste treatment facilities, for research and demonstrations, and to assist state pollution control programs. The Water Quality Act of 1965 gave states the option of prescribing standards or using Federal government guidelines; all states elected to draft their own. 1972 is the deadline for compliance. Initial responsibility for standards enforcement rests with states, but Federal intervention via court rulings can result. Technological problems are: finding economic methods to treat wastes, counteracting acid mine drainage, oil spills, and agricultural pollution (including pesticide contamination), and solving the combined storm and rain sewer problem. Municipal bonds should be able to finance pollution control programs, although revenue bonds and service charges will tend to finance treatment plants. Present programs are advances, but problems are not always solved when requirements are met. Vigilance, pressure, and research are still needed. (Powers-Wisconsin)
W70-05548

GRACI V UNITED STATES (FEDERAL GOVERNMENT'S LIABILITY FOR FLOOD DAMAGE).
301 F Supp 947-956 (ED La 1969).

Descriptors: *Louisiana, *Flood damage, *Damages, *Federal government, Structures, Navigable waters, Construction, Projects, Channel flow, Judicial decisions, Floods, Channel improvement, Costs, Levees, Navigation Legal aspects, Mississippi River, Flood protection, Outlet works, Legislation.
Identifiers: Flood Control Act of 1928.

Plaintiffs, private landowners, sued the United States for damages arising from the flooding of

their property during a hurricane, alleging that the flooding was caused by negligent construction of a navigation channel. The United States here requested a rehearing on its motion to dismiss. The government argued that article 3 of the Flood Control Act of 1928, which states that no governmental liability shall arise from flood damage, overrode any waiver of immunity under the Federal Tort Claims Act. The court held that article 3 above did not necessarily override the Tort Claims Act's waiver of immunity in the particular circumstances of this case. The court discussed several cases dealing with the federal government's liability for floodwater damage. It was pointed out that the structure here was not a flood control project but a navigation aid, and the court held that article 3 could not be interpreted as a wholesale immunization from all liability for floodwater damage unconnected with flood control projects. (Caldwell-Florida)
W70-05627

A STUDY OF INSTITUTIONAL FACTORS AFFECTING WATER RESOURCE DEVELOPMENT IN THE LOWER RIO GRANDE VALLEY, TEXAS,
Texas A and M Univ., College Station. Water Resources Inst.
For primary bibliographic entry see Field 06B.
W70-05641

UNITED STATES v 2,457.85 ACRES OF LAND (CONDEMNATION VALUE OF LAND TAKEN BY FLOOD CONTROL PROJECT).

303 F Supp 883-889 (S D Miss 1969).

Descriptors: *Eminent domain, *Compensation, *Mississippi, *Condemnation value, Legal aspects, Levees, Flood control, Condemnation, Judicial decisions, Benefits, Federal government, United States, Floodways, Flooding, Floodwater, Flood damage.

Plaintiff United States, exercising the power of eminent domain, acquired the land involved in this litigation to provide for flood control. Portions of the land condemned for the floodway had been periodically flooded subsequent to the completion of a levee constructed as part of the floodway but prior to condemnation. The sole issue was the amount of just compensation due for the condemnation of the tracts of land. The court held that just compensation was to be determined as of the date of taking but fair market value was to be determined as though the levee had not been constructed. The fact that no crops had been planted in the flooded fields and no claim for damages to crops was made did not preclude a finding that the land had been damaged as to its marketability by becoming a part of the floodway before condemnation. (Powell-Florida)
W70-05653

WATER SUPPLY - SANITATION - DITCHES (REMOVAL OF DRIFT).
Ohio Rev Code Ann secs 6153.01 thru 6153.26 (Page 1953), as amended, (Supp 1970).

Descriptors: *Ohio, *Obstruction to flow, *Stream improvement, *Aquatic drift, Running waters, Barriers, Legislation, Streamflow, River flow, Alteration of flow, Channels, Diversion, Channel improvement, Streams, Banks, Channel flow, Flow, Driftwood, Sand bars, Silts, Sediments, Legal aspects, Local governments.

A person injured by a drift or other obstruction in the channel or on the banks of a watercourse not on his land may enter the land and remove the obstruction. Notice must be given if the land is occupied. Such person is liable for any avoidable injury to the rights of the owner or occupant, and he may not remove from the land the substances composing the drift. The county, after notice to the person responsible, may remove any obstruction which blocks the free flow of any watercourse or which endangers any road. Taxpayers may petition the county for removal of any obstruction at the county's expense. The county may also remove obstructions upon petition by the adjacent landowner if removal is in the public interest. If the land benefited by the removal is in two or more counties, the commissioners of each county must meet to apportion the work. Provisions are made for notice and hearing on the various petitions. Appeal is made to the probate court and is heard before a jury. The county has the same power to keep a channel clear as it has to clear it initially. (Douberley-Florida)
W70-05660

PORT AUTHORITIES (ESTABLISHMENT, AUTHORITY, AND REGULATION OF PORT AUTHORITIES).
Ohio Rev Code Ann secs 4582.01 thru 4582.20 (Page, 1965), as amended, (Supp 1970).

Descriptors: *Ohio, *Port authorities, *Harbors, *Lake Erie, Legal aspects, Legislation, Cities, Federal government, State governments, Interagency cooperation, Water resources development, Administration, Lakes, Channels, Channel improvement, Drainage systems, Recreation facilities, Riparian land, Riparian rights, Docks, Piers, Costs, Taxes, Navigation, Eminent domain, Right-of-way, Easements, Watercourses (Legal).

Any municipal corporation or county may create a port authority or may join an existing port authority. A county creating a port authority must fully compensate the municipalities within the county for their prior waterfront investments. A board of directors governs each port authority. A port authority may: (1) purchase, construct, and operate commercial and recreational facilities; (2) improve any watercourse necessary to development of port facilities; (3) issue bonds to finance authorized activities; (4) exercise the power of eminent domain when necessary for the construction or efficient operation of any of its facilities; (5) enter into contracts or agreements with other governmental agencies; and (6) contract for construction or improvement of facilities in accordance with certain enumerated restrictions. Procedures are established which enable the owners of land abutting Lake Erie and within the jurisdiction of a port authority to enter into leases of adjacent submerged land from the state for purposes of constructing improvements. The Director of Public Works must approve leases of this type. (Casey-Florida)
W70-05661

MUNICIPAL CORPORATIONS- SALE OR LEASE OF PROPERTY (USE, LEASE AND CONTROL OF LAKE ERIE WATERS AND SOIL).
Ohio Rev Code Ann secs 721.04, 721.05, 721.09, 721.11 (Page, 1953), as amended, (Supp, 1970).

Descriptors: *Ohio, *Lake Erie, *Cities, *Land development, Legislation, Municipal water, Landfills, Land forming, Land management, Docks, Bulkhead line, Bulkheads, Coastal structures, Piers, Highways, Road construction, Assessments, Cost repayment, Cost allocation, Cost sharing, Shores, Littoral, Legal aspects, Land tenure, Real property, Land use.

Municipal corporations bordering Lake Erie may operate docking and terminal facilities on municipal property or on artificially filled state property beyond the shoreline. They may also regulate the establishment of harbor lines and other encroachments on the territory. Municipal authority over existing land, or land created by filling, extends two miles beyond the natural shoreline and is subject to any rights of the federal government. Land filled or improved by the upland owner may not be taken by the municipality without following the procedures provided. Rentals collected for the use of such land or facilities may be used only for the improvement of navigation and water commerce. Any municipality having jurisdiction over waterfront property may develop the waterfront by constructing bulkheads and filling property out to the bulkheads. Land benefited by such development may be assessed for the cost of same, and bonds may be issued in anticipation of the assessments. (Douberley-Florida)
W70-05771

FISH AND GAME--PRESERVES AND RESTORATION PROJECTS (GAME FISH MANAGEMENT AND PROTECTION).
Tenn Code Ann secs 51-601 thru 51-616 (1966).

Descriptors: *Tennessee, *Administrative agencies, *Fish management, *Fish conservation, Fish, Fishing, Fish stocking, Bodies of water, Regulation, Supervisory control (Power), Federal government, Recreation, Projects, Waterfowl, Wildlife conservation, Legal aspects, Legislation, Taxes, Leases, Financing, State jurisdiction.
Identifiers: *Fish preserves, *Fish restoration, Penalties (Criminal), Reservations.

The Game and Fish Commission has the power to establish reservations, refuges or wildlife management areas for the protection and propagation of fish, and shall expend funds to stock reservations with fish. Criminal penalties are provided for unlawful trespass and taking of fish on reservations. The Commission has the power to acquire waters for fish preserves and to execute contracts for the purchase, sale or lease of such preserves. Delinquent tax lands may be a source for establishment of fish preserves. The method of payment for fish preserves is described. The Governor may designate certain waters as fish preserves. The Commission may set aside state waters as fish preserves and establish regulations concerning the taking of fish from such preserves. The state consents to the purchase of waters by the United States government to further wildlife conservation. The state assents to federal aid in fish restoration and management projects. The Director of the Commission is empowered to acquire the exclusive fish rights of privately owned waters, and such rights shall include the power to regulate the fishing in such areas. The Director may sublet these rights to other governmental agencies. (Duss-Florida)
W70-05772

MUNICIPALLY OWNED UTILITIES: FIRST, SECOND, THIRD, AND FOURTH CLASS CITIES.

Mo Ann Stat secs 91.090 thru 91.300 (1952).

Descriptors: *Missouri, *Public utilities, *Water works, *Local governments, Water supply, Pipelines, Water costs, Water delivery, Contracts, Water distribution (Applied), Water rates, Water requirements, Buildings, Easements, Right-of-way, Reservoirs, Financing, Administrative agencies, Construction, Construction costs, Compensation, Cities, Legislation.
Identifiers: Revenue bonds, Liens.

First, second, third, and fourth class cities and special charter cities of 3,000 to 150,000 inhabitants may erect, acquire, maintain and operate waterworks to supply water to inhabitants and to persons beyond the city limits. Reasonable rates may be charged for water so supplied. Every such city may purchase all equipment necessary for a waterworks system or may purchase a system currently in operation in the city. If approved by popular election, the city may issue revenue bonds in the manner provided to finance the acquisition and operation of the waterworks. The system shall be controlled and managed by a board of waterworks commissioners and a waterworks manager who may issue these bonds which shall constitute a first lien on the waterworks property. Provisions are made for construction contracts when no waterworks are already in operation in the city. The city shall pay the board of waterworks commissioners for all water furnished to the city for fire protec-

tion, street cleaning, and consumption by public agencies. Private recipients shall also pay reasonable rates for water furnished to them. (Dearing-Florida)
W70-05775

CONDEMNATION OF PRIVATE PROPERTY (THIRD CLASS CITIES).

Mo Ann Stat sec 88.497 (1952).

Descriptors: *Missouri, *Condemnation, *Channel improvement, *Cities, Community development, City planning, Legislation, Legal aspects, Urbanization, Utilities, Easements, Eminent domain, Right-of-way, Watercourses (Legal), Rivers, Public benefits, Parks.

Third class cities may condemn private property for public use for the purpose of establishing, opening, widening, extending or altering any wharf, creek, river, watercourse or public park and for any other necessary public purpose. (Powell-Florida)
W70-05785

ORDINANCES FOR PUBLIC WORKS (SECOND CLASS CITIES).
Mo Ann Stat sec 88.400 (1952).

Descriptors: *Missouri, *Cities, *Financing, *Bridge construction, Public utilities, Community development, Construction costs, Legislation, Legal aspects, Urbanization, Project planning, Cost allocation, Construction, Maintenance, Utilities, Bridges, Culverts, Sewers, Highways, Local governments, Repairing.

Second class cities are empowered to repair and reconstruct any paving, macadamizing, guttering or curbing and to construct, reconstruct, and repair sidewalks, bridges, culverts, sewers and crosswalks. The cost of bridges, culverts, public sewers and footwalks across streets, avenues, alleys and other highways is paid out of the general revenue fund of the city. (Powell-Florida)
W70-05798

POWER TO LEVY AND COLLECT TAXES FOR GENERAL REVENUE PURPOSES, AND TO IMPROVE STREETS, ALLEYS, SIDEWALKS, BRIDGES, ETC. (THIRD CLASS CITIES).
Mo Ann Stat sec 88.507 (1952).

Descriptors: *Missouri, *Cities, *Assessments, *Bridge construction, City planning, Community development, Urbanization, Legal aspects, Legislation, Civil engineering, Engineering structures, Taxes, Construction maintenance, Maintenance costs. Construction costs, Bridges, Culverts, Roads, Utilities, Financing.

Third class cities are empowered to build and repair sidewalks, bridges, culverts and crosswalks. The cost of bridges, culverts, and footwalks across streets and alleys are paid out of the city's general revenue fund. Allocation and assessment of construction and repair costs are regulated. (Powell-Florida)
W70-05818

ARKANSAS STATE HIGHWAY COMM'N V ORMOND (COMPENSATION FOR CONDEMNED LAND).
448 SW 2d 354-364 (Ark 1969).

Descriptors: *Arkansas, *Judicial decisions, *Condemnation, *Condemnation value, Eminent domain, Legal aspects, Right-of-way, Compensation, Water law, Land appraisal, Land development, Land resources, Fish farming, Fish, Fisheries, Fish hatcheries, Catfishes, Administrative agencies, Highways.

Appellant highway commission condemned a portion of land owned by appellee. Appellee was awarded $12,000 as just compensation. Appellant contends that appellee's valuation of the taken land, based on its potential income when used to raise catfish, was improperly admitted into evidence because appellee was not a commercial fisheries expert. Appellee contended also that there was no substantial evidence to support the verdict. There was testimony by a real estate agent valuing the land at $17,100. The court held that appellee's testimony as to the proposed use of the land was admissible, but that his opinion as to its value for such purpose should have been excluded. However, the admission of appellee's testimony was not prejudicial since the valuation of the land by other witnesses was sufficient to justify an award of $12,000 by the jury. The highest and best use of a landowner's property, and its value, is a question for the jury. Judgment affirmed for appellee. (Dye-Florida)
W70-05835

WATER RESOURCES (PEARL RIVER VALLEY WATER SUPPLY DISTRICT ACT).
Miss Code Ann secs 5956-51 thru 5956-53, 5956-55 thru 5956-58, 5956-61, 5956-63 thry 5956-67, 5956-77 (Supp 1968).

Descriptors: *Mississippi, *Water conservation, *Water districts, *Water resources development, Water resources, Legal aspects, Legislation, Water policy, Water utilization, Water quality, Channels, Surface waters, Water management (Applied), Multiple-purpose projects, Non-structural alternatives, Project purposes, Water allocation (Policy), Water quality control, Pollution abatement, Water conveyance, Watershed management, Water storage, Environmental sanitation, Structures.

The waterways and surface waters of Mississippi are among its basic resources. The preservation, conservation, storage and control of such waters are necessary to insure an adequate, sanitary water supply, to promote the balanced economic development of Mississippi and to aid in flood control, conservation and development of state forests, land irrigation and pollution abatement. Toward the accomplishment of these purposes, as they relate to the Pearl River, there may be organized the Pearl River Valley Water Supply District which may: (1) impound the overflow and surface water of the Pearl River by the construction of dams, reservoirs, works, plants and other factilities; (2) constuct or acquire all works, plants, or other necessary facilities for the purpose of processing and transporting water to cities for domestic, municipal, commercial, industrial, agricultural and manufacturing purposes; (3) control open channels for water delivery purposes; (4) forest and reforest the project area and prevent soil erosion and floods within the area; (5) control, preserve, and store the Pearl River waters for land irrigation and water pollution prevention; and (6) overflow and inundate any public lands and public property within the project area. (Powell-Florida)
W70-05837

WATER RESOURCES (PEARL RIVER VALLEY WATER SUPPLY DISTRICT ACT).
Miss Code Ann secs 5956-51 thru 5956-53, 5956-55 thru 5956-58 (Supp 1968).

Descriptors: *Mississippi, *Water resources, *Water districts, *Water resources development, Water conservation, Legal aspects, Legislation, Water policy, Water utilization, Channels, Surface waters, Water management (Applied), Multiple-purpose projects, Pollution abatement, Water quality, Environmental sanitation, Water storage, Non-structural alternatives, Eminent domain, Condemnation, Construction, Maintenance.

Mississippi's basic resources include its waterways and surface waters. Previously, such waters have not been fully conserved. Conservation of such waters is necessary to promote the economic development of the state. Preservation, conservation and control of the Pearl River waters are for the general welfare of all Mississippians. The Pearl River Valley Water Supply District is organized to implement the declared legislative policy in regards to the waterways and surface waters of Mississippi. The District is to be organized and established by a chancery court pursuant to a petition filed by the Pearl River Industrial Commission. The procedures for creation of the District, including proceedings after a petition is filed and hearings on the petition, are enumerated. (Powell-Florida)
W70-05838

WATER RESOURCES (PEARL RIVER VALLEY WATER SUPPLY DISTRICT ACT).
Miss Code Ann secs 5956-61, 5956-63 thru 5956-67, 5956-77 (Supp 1968).

Descriptors: *Mississippi, *Water resources development, *Water resources, *Water conservation, Water policy, Legal aspects, Legislation, Water utilization, Recreation facilities, Water management (Applied), Environmental sanitation, Water conveyance, Water quality control, State governments, Pollution abatement, Multiple-purpose projects, Channels, Surface waters, Regulation, Supervisory control (Power).

The Pearl River Valley Water Supply District is given the power to: (1) impound overflow water and the surface water of the Pearl River by constructing dams, reservoirs, works, plants and other facilities designed to control, store, preserve, use, distribute and sell such waters; (2) construct or acquire works, plants and other facilities designed to process and transport overflow or surface water to cities for domestic, municipal, commercial, industrial, agricultural, and manufacturing purposes; (3) control open channels for water delivery purposes; (4) aid in the prevention of damage to persons or property from Pearl River waters; (5) aid in the prevention of soil erosion and floods; and (6) control, store and preserve the Pearl River waters for land irrigation and for water pollution prevention. Powers relating to the management and regulation of the District's affairs are provided. The District shall establish or provide for public parks and recreational facilities and for the preservation of fish and wildlife. The Board of Directors of the District shall promulgate all regulations to secure, maintain and preserve the sanitary conditions of all reservoir water, to prevent water waste and to govern all recreational activities within the District. The District shall act jointly with political subdivisions of Mississippi and other states and with the federal government in the performance of the purposes and services authorized in the act. (Richard Powell-Florida)
W70-05839

ARKANSAS V TENNESSEE (DETERMINATION OF STATE BOUNDARY LINE).
90 S Ct 784-787 (1970).

Descriptors: *Arkansas, *Tennessee, *Boundary disputes, *Avulsion, Mississippi River, Boundaries (Property), Accretion (Legal aspects), Ownership of beds, Shores, Legal aspects, Streams, Streamflow, River flow, Alteration of flow, Running waters, Streambeds, Thalweg, Channels, Erosion, Judicial decisions, Beds under water, River beds, Channel morphology, Channel erosion, Meanders.

The State of Arkansas brought an action to settle a boundary dispute with the State of Tennessee. The established state line was the thalweg, or the streamboat channel, of the Mississippi River. The River had migrated northward and westward until 1912 when an avulsion occurred leaving Tennessee lands on the Arkansas side of the new river channel. The water in the thalweg became stagnant. The court affirmed the report of the special master which fixed the boundary in the middle of the old abandoned channel. The court stated that where a running stream that serves as a boundary is changed naturally and gradually by erosion and accretion, the boundary follows the varying course of the stream. However, where the stream suddenly

forms a new bed by the process of avulsion, and the water in the old channel becomes stagnant, the boundary is not changed. The boundary then becomes fixed in the middle of the old abandoned channel, irrespective of subsequent changes in the new channel. The gradual filling of the channel's bed that follows is treated as an effect of the avulsion and not as an accretion to the shores. (Douberley-Florida)
W70-05840

REETZ V BOZANICH (CONSTITUTIONALITY OF COMMERCIAL FISHING REGULATIONS).
90 S Ct 788-790 (1970).

Descriptors: *Alaska, *Permits, *Commercial fishing, *Regulation, Salmon, Fishing gear, Judicial decisions, Jurisdiction, Legal aspects, Commercial fish, Nets, State governments, Federal government, Legislation.
Identifiers: Licenses, Constitutional law.

According to applicable Alaska laws, salmon net gear licenses for commercial fishing could be issued only to those who had held a license for that specific area since 1965 or who had held a commercial fishing license for any three years since 1960 and had actually fished that area. Appellees, nonresident fishermen, could not qualify for a salmon net gear license and challenged these laws as violative of both the state and federal constitutions. The Alaska Constitution provided that fish in their natural state were reserved to the people for common use, and that no exclusive right of fishery could be created. The District Court denied appellant's motion to dismiss or to stay the proceedings pending determination of the Alaska constitutional question by Alaska courts. The Supreme Court held that the federal court should have stayed its determination until the state constitutional question had been resolved. The constitutional provisions had never been interpreted by an Alaska court, and a state court decision conceivably could have avoided any decision under the fourteenth amendment. (Douberley-Florida)
W70-05841

UNITED STATES V REYNOLDS (DETERMINATION OF THE SCOPE OF THE PROJECT IN CONDEMNATION PROCEEDINGS).

90 S Ct 803-809 (1967).

Descriptors: *Eminent domain, *Condemnation value, *Project planning, *Compensation, Federal government, Condemnation, Projects, Legal aspects, Judicial decisions, Project purposes, Optimum development plans, Reservoirs, Recreation facilities, Cost repayment, Federal project policy.
Identifiers: Just compensation, Project scope.

The United States brought an action to condemn respondent's land for a reservoir project. Respondent claimed that a portion of the land was for recreational facilities adjacent to the project and was not within the original scope of the project. If the land was outside the project itself, the rule of just compensation would require that any increase in the market value attributable to the proximity of the project be taken into account. The District Court submitted to the jury the issue of the scope of the project. The Supreme Court reversed, finding that the issue should have been determined by the judge. The Court stated that there is no constitutional right to a jury in eminent domain proceedings, and the Federal Rules of Civil Procedure provide for a jury trial only on the issue of just compensation. The Court limited the issue of just compensation to the narrow question of the amount of compensation to be awarded. All other issues, including the issue of the scope of the project, are for the judge to determine. (Douberley-Florida)
W70-05842

LITZEL V CANAL AUTHORITY (TITLE ACQUIRED BY EMINENT DOMAIN FOR RECREATIONAL PURPOSES).

230 So 2d 164-166 (1st D C A Fla 1969).

Descriptors: *Florida, *Eminent domain, *Judicial decisions, *Condemnation, Legal aspects, Canals, Administrative agencies, State governments, Legislation, Projects, Land tenure, Recreation, Recreation facilities.

The Canal Authority of Florida, in an eminent domain proceeding, sought a fee simple title to land which it planned to use primarily for recreational purposes. The district court of appeal held that the question of whether a condemnor should be awarded a fee simple title to property depended on the necessity for such title. The court found no authorization for the Authority's acquisition of lands for recreational purposes. To award a fee simple title to the condemnor would deprive the owner of his property without due process of law. (Hubener-Florida)
W70-05843

SPORTMEN'S ENTERPRISES, INC V UNION BARGE LINE CORP (DEFINITION OF A NARROW CHANNEL).
306 F Supp 1376-1388 (N D Miss 1969).

Descriptors: *Mississippi, *Boating regulations, *Downstream, *Mississippi River, Channel flow, Rivers, Streamflow, Streams, Upstream, Channel morphology, Channels, Waterways, Legal aspects, Navigation, Navigable waters, Navigable rivers, Streambeds, Admiralty.
Identifiers: *Narrow channel.

On investigation of a collision between two towboats in the Mississippi River the court determined that the particular rules of navigation which should have been observed depended on whether or not the site of collision was a narrow channel. The court stated that whether or not the area was a narrow channel was a mixed question of law and fact which had to take into account the size and depth of the channel. (Hubener-Florida)
W70-05844

FONTENELLE V OMAHA TRIBE OF NEBRASKA (OWNERSHIP OF ACCRETION).

298 F Supp 855-862 (D D C 1969).

Descriptors: *Nebraska, *Land tenure, *Accretion (Legal aspects), *Boundary disputes, Riparian land, Riparian rights, Boundaries (Property), Surveys, Mapping, Navigable rivers, Judicial decisions, State governments, Avulsion, Bank erosion, Meanders, Ownership of beds, Missouri River, Legal aspects, Third party effects, River beds.
Identifiers: *Reliction.

Plaintiffs brought an action to quiet title to property formed by the movement of the Missouri River after the official United States survey was made. The court found that the change was caused by reliction, and stated that reliction was governed by the principles relating to accretion. The general rule is that land added by accretion and reliction to tracts which were riparian at the time of official survey and mapping is the property of the riparian owner. As the plaintiffs' property was riparian land at the time of the survey, they were entitled to the lands in question. The fact that the lands in question were originally included in an Indian reservation under United States patent did not call for the application of different rules and principles than would ordinarily be applied. (Caldwell-Florida)
W70-05846

VILLAGE OF GULFPORT V BUETTNER (NECESSITY OF CITY ORDINANCE AUTHORIZING CONDEMNATION OF PROPERTY FOR RECREATIONAL USE).

251 N E 2d 905-909 (3d Dist Ill. 1969).

Descriptors: *Illinois, *Condemnation, *Recreation facilities, *Legislation, Judicial decisions, Cities, Docks, Marinas, Boat-launching ramps, Recreation, Boating, Governments, Public rights, Legal aspects, Eminent domain, Local governments, Project planning, Real property, Harbors, State governments, Federal government, Construction.
Identifiers: Ordinances.

Plaintiff municipality initiated a condemnation proceeding for land to be used for a recreational harbor. The municipality had adopted a resolution to establish the harbor and acquire the property pursuant to the status authorizing the proceedings. Defendant challenged the proceedings on the grounds that the requisite ordinance was not passed by the municipality and that no approval had been obtained from the proper state and federal authorities. The trial court denied plaintiff's motion to amend and allege approval by the government officials and dismissed the petition. The appellate court affirmed. It found that the building of a launching ramp was within the provision authorizing the construction of harbors. The statutory procedures required the municipality to adopt an ordinance prescribing a permanent rule of conduct relating to the improvement. The resolution submitted by plaintiff was not sufficient to satisfy the statute because a resolution is only of special and temporary character. (Douberley-Florida)
W70-05895

6G. Ecologic Impact of Water Development

NEW CONCEPT FOR MANAGING AQUATIC LIFE SYSTEMS,
Virginia Polytechnic Inst., Blacksburg. Dept. of Biology.
John Cairns, Jr.
Journal, Water Pollution Control Federation, Vol. 42, No. 1, p 77-82, Jan. 1970. 12 ref.

Descriptors: *Environment, *Management, *Quality control, *Warning systems, Bioassay, Aquatic life.
Identifiers: Simulation, Biological information system, Life support functions.

In the past, our response to environmental problems has been almost entirely defensive. This response pattern is not effective, and management and planning are badly needed. Some prerequisites for making full use of natural ecosystems without damaging them are: predictions systems which can predict the consequences of various types and intensities of environmental use; simulation techniques, approximating various uses of the environment and the consequences of all combinations and intensities of use; rapid biological information systems, both 'in-stream' and 'in-plant' which will permit environmental quality control as well as an early warning of impending problems; and the identification of the life support functions of our environment and the requirements of the essential components. (Speakman-Vanderbilt)
W70-05795

07. RESOURCES DATA

7A. Network Design

THE METHODS OF STUDYING THE FREE UNCONFINED GROUNDWATER REGIME IN IRRIGATION REGIONS,
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
For primary bibliographic entry see Field 04B.
W70-05731

PRINCIPLES ON NETWORK DESIGN AND BASIC DATA TO STUDY GROUNDWATER BALANCE,
Research Inst. for Water Resources Development, Budapest (Hungary).
K. Ubell.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 56-63, 1968. 8 p, 2 fig, 7 ref.

Descriptors: *Hydrologic data, *Network design, *Aquifers, Hydraulic properties, Hydrologic properties, Water table, Piezometers, Water quality, Discharge (Water), Soil moisture, Tracers, Radioisotopes.
Identifiers: Groundwater data collections.

The study of groundwater balance requires three types of closely interrelated hydrologic measurements. These 3 types are: (1) Constant or nearly constant measurements obtained from single-type surveys showing the geometry, physical and chemical properties of water-bearing formations, hydraulic properties of aquifers and soil hydrological constants; (2) dynamic measurements, including data on water table, piezometric head, discharge, water quality, temperature data, soil moisture and its state of tension; (3) additional observations such as those obtained by use of lysimeters, tracers, environmental isotopes, etc. The basic data necessary to compute the groundwater balance are discussed in more detail for each category. (Carstea-USGS)
W70-05736

RAIN GAGE SPACING AND REPORTED RAINFALL,
Universidad Central de Venezuela, Caracas; and Texas A and M Univ., College Station.
Fernando Alvarez, and Walter K. Henry.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 97-107, March 1970. 11 p, 10 fig, 2 tab, 8 ref. Contract No DAAB07-69-C0203.

Descriptors: *Rain gages, *Network design, Data collections, Surveys, Meteorological data, Statistical methods, Hydrologic data, Regional analysis, Stations.
Identifiers: Guyana, Colombia, Rain-gage networks.

A study was made of the variation of observed rainfall over several areas as related to the density of rain gages. Daily, monthly, and mean rainfall observations are each considered as a function of rain gage density. A study was made of the variation in isohyetal patterns which would be obtained if a variable number of stations was utilized. Numerous maps of each network were analyzed. In all cases the isohyetal patterns became more complex as more stations were utilized. The number of rain gages needed to determine the correct total rainfall for an area appears to depend upon three factors. First is the terrain - if mountainous, more gages are required. Second is the climatic area - the spacing depends upon the mean diameter of the rainstorms. Whenever the rain gage network has gages spaced at a distance less than the diameter of the mean rainstorms, the accuracy of measurement increases. Third is the type of data required - if accurate daily data are needed, the density of gages must be much greater than if monthly totals are needed and a still larger spacing will suffice if long-term means are desired. Better results will be obtained with more gages and with a more uniform spacing. By using the given relationships, the number of gages needed for a specific area can be estimated. In the final consideration, the cost of supporting the network will be the deciding factor. (Knapp-USGS)
W70-05878

7B. Data Acquisition

SAMPLING THE BENTHOS,
Toronto Univ. (Ontario). Dept. of Zoology.
R. O. Brinkhurst.
Great Lakes Institute, University of Toronto, Canada, PR 32, November 1967. Mimeo 7 p. 1 fig.

Descriptors: *Sampling, *Benthos, Specifications, Evaluation.

The ideal benthos sampler, thus far non-existent, should have the following specifications: penetration of at least 20 centimeters, the bite such that all depths are sampled equally in one attempt, a powerful closing mechanism, and a descent toward sediment without a pressure wave. A review of advantages and shortcomings of now available samplers (Kajak, Freshwater Biological Association, England, Jenkin, Orange-peel, Peterson, Wildlife Supply Company's 'Ponar Dredge', Franklin, Ekman, and Benthos Inc), leads to the conclusion that Hydrobios Apparat Gebau of Kiel, Germany, makes the best available but still in need of modification. (Wilde-Wisconsin)
W70-05557

CONTINUOUS MONITORING OF SOIL MOISTURE TENSION PROFILES,
Agricultural Research Service, Fresno, Calif. Soil and Water Conservation Research Div.; and Nevada Bureau of Mines, Reno. Desert Research Inst.
For primary bibliographic entry see Field 02I.
W70-05592

LABORATORY METHOD FOR SUPPLYING MOISTURE UNIFORMLY TO SOIL BY CONDENSATION,
Battelle Memorial Inst., Richland, Wash.; North Dakota Univ., Grand Forks. Dept. of Engineering; Oregon State Univ., Corvallis. Dept. of Mathematics; and Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 03F.
W70-05594

THE USE OF THE COULTER COUNTER FOR THE DETERMINATION OF MARINE PRIMARY PRODUCTIVITY,
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Lab.
D. H. Cushing, H. F. Nicholson, and G. P. Fox.
Journal du Conseil International pour l'Exploration de la Mer, Vol 32, No 1, p 131-151, 1968. 18 fig, 2 tab, 12 ref.

Descriptors: *Sea water, *Analytical techniques, Sampling, Instrumentation, Primary productivity, Standing crop, Detritus, Algae, Reproduction, Chlorophyll, Phytoplankton, Grazing, Nutrients, Copepods.
Identifiers: Particle method, Coulter counter, Reproductivity rate, Carbon-14, Optical density, Particle volume, Faroe Islands (Denmark), Grazing experiment, Pulse amplitude/digital converter.

The Coulter counter consists of two vessels connected by a small tube, all filled with an electrolyte; electrodes immersed in each vessel register the variation in the current produced by particles passing through the connecting tube. Addition of a pulse height analyzer and a pulse amplitude/digital converter permitted estimation of standing crop of phytoplankton, detritus, and reproductive rate on samples of raw sea water near the Faroe Islands (Denmark). The advantages of this particle method are: observations can be made in seconds on very small quantities of water (2 milliliter), and a high degree of replication can be obtained in a few minutes. Limitations of carbon-14 and chlorophyll methods of phytoplankton analyses are pointed out. (Wilde-Wisconsin)
W70-05650

QUANTITATIVE MICRO-DETERMINATION OF LIPID CARBON IN MICROORGANISMS,
California Univ., San Diego, La Jolla. Inst. of Marine Resources; and Scripps Institution of Oceanography, La Jolla, Calif. Div. of Marine Biology.
O. Holm-Hansen, J. Coombs, B. E. Volcani, and P. M. Williams.
Analytical Biochemistry, Vol 19, No 3, p 561-568, 1967. 1 fig, 1 tab, 17 ref.

Descriptors: *Analytical techniques, *Microorganisms, *Lipids, Light, Algae, Temperature, Carbon dioxide, Oxidation, Chemicals, Carbon, Gravimetry.
Identifiers: Chloroform-methane extracts, Lipid carbon, Chloroplasts, Infrared analysis.

The described procedure for the quantitative determination of lipid in microorganisms employs combustion of the solvent extracts to carbon dioxide and measurement of the liberated carbon dioxide by infrared analysis. The method permits analyses of samples containing as little as 20 micrograms of lipid, and the results are comparable to those obtained by gravimetric and colorimetric methods. (Wilde-Wisconsin)
W70-05651

INFLUENCE OF METHOD FOR REMOVAL OF SESTON ON THE DISSOLVED ORGANIC MATTER. II. COBALAMINS,
Washington Univ., St Louis, Mo. Dept. of Botany.
Bruce C. Parker.
Journal of Phycology, Vol 5, No 2, p 124-127, 1969. 1 tab, 5 ref.

Descriptors: *Analytical techniques, *Organic matter, *Seston, Vitamin B, Water chemistry, Chemical analysis, Filtration, Centrifugation, Dialysis, Bioassay, Euglena, Sewage, Lakes, Water pollution effects, Missouri, Scenedesmus, Adsorption, Rainfall, Water pollution sources.
Identifiers: *Organic solutes, *Cobalamins, Vitamin B-12, Millipore filtration, Biodialysis, Continuous flow centrifugation, Error analysis, Westchester Lake (Mo), Coulet counter, Haemacytometer enumeration, Membrane filters, Occlusion, Euglena gracilis Z bioassay.

Study of organic solutes in natural waters necessitates removal of organisms and particulate detritus. Usual methods of sample treatment, including filtration and centrifugation, influence water composition. A previous study describes effects of seston removal on total dissolved carbon by continuous flow centrifugation, Millipore filtration, and biodialysis. Investigations have been extended to examine recovery of cobalamins (vitamin B-12), which may be a more sensitive index. Cobalamins were estimated by bioassay in which growth of Euglena gracilis Z is assessed by counting cells with Coulter counter or in haemacytometer. Cobalamin concentrations reported range from less than 0.25 to 16.0 picograms/milliliter. Results indicate several probable sources of error: unpredictable occlusion of pores of Millipore membrane during filtration; irreversible cobalamin adsorption by filter; and cell injury and leakage during centrifugation. While soluble cobalamin, for some samples, were in good agreement among three methods, others showed discrepancies. Validity interpretation of total versus sestonic cobalamin-determinations should consider such variations. Biodialysis is usually equally acceptable as other methods. This technique involves placing in situ a chamber containing sterile distilled water retained between two membrane filters; dialysis of organic solutes from ambient water into chamber proceeds to equilibrium, whereas seston is excluded. (Eichhorn-Wisconsin)
W70-05656

DETERMINATION OF SOIL DENSITY AND WATER CONTENT BY FAST NEUTRONS AND GAMMA RAYS,
Du Pont de Nemours (E. I.) and Co., Aiken, S.C.
For primary bibliographic entry see Field 02G.
W70-05682

A METHOD OF DERIVATION OF NONCONSTANT WATERSHED RESPONSE FUNCTIONS,
Agricultural Research Service, Athens, Ga. Southeast Watershed Research Center.

For primary bibliographic entry see Field 02A.
W70-05685

THE PRINCIPAL CRITERIA OF THE ANALYSIS OF GEOPHYSICAL FIELDS IN HYDROGEOLOGICAL INVESTIGATIONS WITH SPECIAL REFERENCE TO DESERT REGIONS OF KAZAKHSTAN,
Kazakhstan Geophysical Agency, Alma-Ata (USSR); and All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).
Yu. F. Anashin, V. V. Brodovog, A. P. Gavelya, R. N. Kirilov, and G. N. Zavarzin.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 249-261, 1968. 13 p, 9 fig.

Descriptors: *Geophysics, *Groundwater basins, *Surveys, Groundwater movement, Flow rates, Fresh water, Maps, Mapping, Magnetic studies, Seismic studies, Seismic properties.
Identifiers: *USSR, *Kazakhstan, Asia, Africa, Geophysical exploration.

Geophysical methods of groundwater prospecting such as electric, seismic, gravity, and magnetic surveys have been extensively used in the drought areas of Kazakhstan. Geophysical data in connection with geological and hydrological information are used to determine the extent and depth of water-bearing strata, the degree of mineralization of groundwater, and the direction and rate of groundwater flow. Geophysical data are presented as: (1) geophysical field maps; (2) structural contour maps; (3) electric and seismic geological cross sections; and (4) maps of hydrogeological prediction. Experience obtained in Kazakhstan can be used in other desert regions of Asia and Africa. (Carstea-USGS)
W70-05728

THE USE OF AIRPHOTO-INTERPRETATION TECHNIQUES IN WATER RESOURCES SURVEYS,
Caesar Voute.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 75-80, 1968. 6 p, 17 ref.

Descriptors: *Water resources, *Aerial photography, *Aquifers, Base flow, Surveys, Water loss, Dams, Dam foundations, Slope stability, Phreatophytes, Water table, Saline water, Brackish water, Halophytes, Remote sensing.
Identifiers: Airphoto interpretation.

Distinction between areas with low, moderate, high and very high peak runoffs and with large or small base flows is possible by the interpretation and measurement of various features observed on single aerial photographs using stereoscopic pairs. Geological photo-interpretation combined with hydrogeological and geotechnical appraisal of the features observed will indicate the existence of underground losses from reservoirs or at damsites, as well as type of foundation and slope stability. Phreatophytes may indicate areas with shallow watertable whereas halophytes and white efflorescences are good indicators of brackish or saline groundwater. Color photography, infrared photography, special film/filter combinations and remote sensing techniques are getting more and more attention in hydrological studies. (Carstea-USGS)
W70-05734

USE OF ALGAL CULTURE METHODS IN EUTROPHICATION RESEARCH (IN NORWEGIAN),
Norsk Institutt for Vannforskning, Blindern.
For primary bibliographic entry see Field 05C.
W70-05752

AN AUTOMATED SYSTEM FOR THE DETERMINATION OF CHEMICAL OXYGEN DEMAND,
Upper Tame Main Drainage Authority, Birmingham (England).
For primary bibliographic entry see Field 05A.
W70-05762

SEDIMENT MEASUREMENT TECHNIQUES: E. AIRBORNE SEDIMENT.

Prepared by Task Committee on Preparation of Sedimentation Manual ASCE Committee on Sedimentation of the Hydraulic Division. ASCE Proceedings, Journal Hydraulics Division, Vol 96, No HY1, Paper 7001, p 29-41, January 1970. 13 p, 6 fig, 43 ref.

Descriptors: *Dusts, *Measurement, *Sampling, *Monitoring, Air pollution, Aerosols, Particle size, Data collections, Test procedures, Analytical techniques, Filtration, Turbulence, Mixing, Sediment transport.
Identifiers: Dust measurement.

Measuring sensors and collectors and analysis methods for measuring and analyzing aerial dusts are presented. Plastic sheets, trays, and cups; glass beakers; outer cylinders of raingages; the Nipher snowgage with inverted bell shield; the Toronto and detroit collectors; and the dual purpose sequential sampler employing microscope slides are some of the devices which use the sedimentation or settling technique for making dustfall measurements. Filtration, impingement, electrostatic precipitation, thermal precipitation, and centrifuging principles are used in devices for measuring suspended aerosol contaminants. Fiber and membrane or molecular filters, the Greenburg-Smith and midget impingers, the cascade impactor, the Chatfield sequential and the CERL directional suspension samples, and the Goetz centrifugal sampler are examples of the devices employing some of these principles. Special collectors that have been used to measure aerial dust originating from wind erosion are described. Techniques and instruments for chemical, morphological, and count and size analyses of airborne sediment are also presented. (Knapp-USGS)
W70-05886

A NEW RECORDING TURBIDITY METER FOR RIVERS,
Natal Univ., Durban (South Africa).
William James.
International Association Scientific Hydrology Bulletin, Vol 15, No 1, p 91-95, March 1970. 5 p, 6 fig, 1 ref.

Descriptors: *Turbidity, *Light penetration, *Instrumentation, Opacity, Optical properties, Sediment transport, Suspended load, On-site tests.
Identifiers: Turbidity meters.

An expensive continuously recording turbidity transducer on two different types of mounting has been developed at the University of Natal, and installed at two stations in the Umgeni River system. The geometry and components of the transducers are detailed, and a sampler used to calibrate the transducers is also described. A portable turbidity meter has also been developed. (Knapp-USGS)
W70-05901

7C. Evaluation, Processing and Publication

PROPOSAL FOR A U.S. NATIONAL WATER ATLAS,
National Research Council, Washington, D.C. Committee for the International Hydrological Decade.
L. A. Heindl.
Water Resources Bulletin, Vol 6, No 1, p 1-6, January-February 1970. 6 p, 5 ref.

Descriptors: *Water resources, *Mapping, Data collections, Hydrologic data, Hydrogeology, Hydrology, Geology, Water quality, Stream gages, Observation wells, Climatology, Meteorology, Sedimentology.
Identifiers: National Water Atlas (USA).

The U. S. National Committee for the International Hydrological Decade is proposing a National Water Atlas as a contribution to the improvement of the quality of information available for this Nation's large-scale planning and management studies. The atlas would provide hydrological maps of the United States and its principal basins and of its territories. The nationwide maps would be at a scale of 1:5,000,000 and the 17 principal basins at 1:2,500,000. The principal basins will be those delineated by the Water Resources Council. Wherever feasible and appropriate, the data will be presented with a common standard period of record, preferably 1941-70, as a base. Map subjects would include station networks, radiation, precipitation, snow and ice, evaporation, atmospheric vapor fluxes, surface-water discharge, groundwater storage and discharge, chemical quality, sediment discharge, water temperatures, and soil moisture. The list of map subjects and types of data shown within each subject are flexible and open-ended so that additional maps could be added to the atlas as information is available or as new needs arise. (Knapp-USGS)
W70-05707

METHODS OF GROUNDWATER BALANCE EVALUATION APPLIED IN THE USSR - DEVELOPMENT OF METHODS OF STUDY OF GROUNDWATER BALANCE,
For primary bibliographic entry see Field 02F.
W70-05727

METHODS OF GROUNDWATER UNSTEADY FLOWS THEORY,
Akademiya Nauk SSSR. Dept. of Applied Hydrodynamics.
For primary bibliographic entry see Field 02F.
W70-05730

ESTIMATION OF GROUNDWATER BALANCES IN ENGLAND,
Institute of Geological Sciences, London (England).
Stevenson Buchan.
In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 126-134, 1968. 9 p, 1 fig, 31 ref.

Descriptors: *Water balance, *Water resources, *Water storage, Geologic mapping, Aquifers, Wells, Boreholes, Water levels, Meteorological data, Streamflow.
Identifiers: *England, Groundwater balance.

Geological maps on the scale of 1:63,360 for the whole county and 1:10,560 for about a third of it were used for estimation of groundwater balances of the important aquifers in England. The pattern of underground drainage and changes in the level of storage was defined by using information from several hundred-thousand shafts, wells, boreholes, and water level measurements at some 600 sites. Meteorological data and streamflow measurements were also used. Regional and formational groundwater balances in England were initiated by the Institute of Geological Sciences. The water balances are revised at intervals of not more than seven years and are used for computing the water resources of the county. (Carstea-USGS)
W70-05732

THE ARCHIVES FOR GROUNDWATER LEVELS T.N.O. IN THE NETHERLANDS,
Rijksinstituut voor Drinkwatervoorziening, The Hague (Netherlands).
J. H. Beltman.

In: Groundwater, Proceedings of General Assembly of Bern (Sept-Oct 1967), International Association of Scientific Hydrology, Publication No 77, p 64-74, 1968. 11 p, 4 fig, 3 ref.

Descriptors: *Water levels, *Data collections, *Artesian wells, Theoretical analysis, Climatic data, Forecasting, Network design, Research and development, Observation wells, Statistical methods.
Identifiers: Netherlands.

The main purposes of the Archives for Groundwater Levels T.N.O. in the Netherlands are: (1) To collect data of groundwater levels, observed over long periods with a certain frequency in a certain number of observation points for both phreatic and artesian water throughout the Netherlands; (2) to supply, without charge, data on groundwater levels to all interested parties; and (3) to serve for organization of 'Secondary Archives'. The selection of key wells was such that each point was representative of a certain area. A theoretical analysis for such a selection is given. The system allows examination, explanation and prediction of the behavior of groundwater levels with various climatological conditions. The close network of observation points for groundwater levels is indispensable for any hydrological research in the Netherlands. (Carstea-USGS)
W70-05735

COMPUTER AIDED DESIGN OF WASTE WATER TREATMENT PLANTS,
Michigan Univ., Ann Arbor. Dept. of Environmental Health.
For primary bibliographic entry see Field 05D.
W70-05777

NEW CORRELATIONS AND TABLES OF THE COEFFICIENT OF VISCOSITY OF WATER AND STEAM UP TO 1000 BAR AND 1000 DEG C,
Glasgow Univ. (Scotland).
E. A. Bruges, B. Latto, and A. K. Ray.
Int. J. Heat Mass Transfer, Vol. 9, p 465-480, 1966. 9 fig, 7 tab, 46 ref.

Descriptors: *Temperature, *Thermal properties, *Viscosity, Steam, Heated water, Physical properties, Viscometers, Pressure, Vapor pressure, Rheology, Water vapor, Vapor.

New correlations and tables of the coefficient of viscosity of water and steam are presented. The correlations have the same general format as those appended to the International Skeleton Tables (800 bar, 700 deg C) but take account of recent work, thus permitting values up to the higher limits of 1000 bar and 1000 deg C to be derived. The paper gives references to all the leading works and recommends that systematic and extensive measurements be made in the temperature range 0-400 deg C at all pressures. (Novotny-Vanderbilt)
W70-05783

REAL-TIME COMPUTER CONTROL OF URBAN RUNOFF,
Minneapolis-St. Paul Sanitary District, St. Paul, Minn.
James J. Anderson.
ASCE Proceedings, Journal Hydraulics Division, Vol 96, No HY1, Paper 7028, p 153-164, January 1970. 12 p, 19 fig, 10 ref. FWPCA Grant No 1-MINN.-1.

Descriptors: *Runoff, *Urbanization, *Water control, *Digital computers, Drainage systems, Flow control, Monitoring, Gaging stations, Water management (Applied), Computer programs.
Identifiers: Minneapolis-St. Paul (Minn), Urban hydrology.

Computer control and modernization of combined sewer overflow regulators and an urban hydrology hydraulic mathematical model are described. The system was installed to control the Minneapolis-St. Paul sewer system during stormwater runoff to improve the utilization of the existing interceptor sewers. Key stormwater regulators were modified to provide remote control of hydraulically operated gates and inflatable dams. Trunk sewer and interceptor sewer level monitoring stations and rain gages are used as input to a mathematical model consisting of: (1) rainfall-runoff model; (2) stormwater diversion model; and (3) flood routing in the interceptor sewer. A high density river quality monitoring system was installed to determine quality effects of runoff events and to evaluate the effectiveness of the control system. Automatic sampling and automated wet chemical analysis of wastewater are used to identify hourly quality variations in the wastewater. (Knapp-USGS)
W70-05882

A NATIONAL WATER DATA SYSTEM FOR CHILE,
Geological Survey, Washington, D.C.
William W. Doyel, and Marshall E. Moss.
Geological Survey Open-file report, Marsh 1970. 141 p, 1 fig, 7 append.

Descriptors: *Hydrologic data, *Data storage and retrieval, *Foreign countries, Water measurement, Snow surveys, Automation, Data processing, Standards, Compatability, Coordination, Water resources, Precipitation (Atmospheric), Hydrogeology, Water users, Project planning.
Identifiers: *National water-data system, *Chile, Program planning, Information centers.

At the request of the Chilean Government for assistance in developing a centralized coordinated water data system, a study was made of the current status of data acquisition in Chile and a series of recommendations were developed for specific action. A national water data system is outlined. A unique number system for data sites is presented; formats and forms designed for a catalog of water information are described. Data storage systems are proposed and the total system is outlined with regard to acquisition, flow through, responsiveness, and feedback. A coordinated mechanism involving data acquirers and/or users is suggested. (Land-USGS)
W70-05892

08. ENGINEERING WORKS

8A. Structures

METHOD FOR DETERMINING MINIMUM-COST FARM-IRRIGATION PIPELINE DESIGN,
Soil Conservation Service, Milford, N.H.
For primary bibliographic entry see Field 03F.
W70-05597

THE EFFECTS OF WAVES AND CURRENTS ON SUBMERGED PIPELINES,
Texas Engineering Experiment Station, College Station. Coastal and Ocean Engineering Div.
Derwood O. Ralston, and John B. Herbich.
Available from the Clearinghouse as PB-188 106, $3.00 in paper copy, $0.65 in microfiche. Sea Grant Pub-301, Coastal and Ocean Engr Div Report, COE-101, March, 1969. 128 p.

Descriptors: *Ocean waves, *Pipelines, Submergence, Ocean currents, Seashores, Failure (Mechanics), Maintenance, Costs, Sedimentation, Oil industry, Environment effects, Corrosion.
Identifiers: *Underwater pipelines.

The report is a brief review and summary of selected literature pertaining to the effects of waves and currents on submerged pipe lines.
W70-05619

DESIGN AND CONSTRUCTION OF THE WEI-RIVER BRIDGE IN WU-LING. A HINGED TEE RIGID STRUCTURE BRIDGE OF BUILT-UP PRESTRESSED REINFORCED CONCRETE CANTILEVERS.
Foreign Technology Div., Wright-Patterson AFB, Ohio.

Trans. of T'u Kung Ch'eng Hsueh Pao. Kung Ch'eng Chieh Kou (Mainland China) v 12 n 1 p 2-14, 52 1966. Available from the Clearinghouse as AD-699 233, $3.00 in paper copy, $0.65 in microfiche. Foreign Technology Div Rept no FTD-HT-23-1164-68, 8 Aug 69. 41 p.

Descriptors: *Bridges, *Railroads, *Bridge construction, Cantilevers, Reinforced concrete.
Identifiers: *Cantilever bridges, *Concrete construction, Rigid frame bridges, Prestressed concrete, Translations.

A report is given on the design and construction of the Wei River bridge at Wu-ling, Honan. This bridge is built with prestressed reinforced concrete. It has three spans: the middle span is 50 meters, and the two side spans are 25 meters each. The total length is 105.2 meters. The paper provides extensive data on design, selection of material, construction sequences, and construction techniques.
W70-05620

HYDROLOGIC EFFECTS OF FLOODWATER-RETARDING STRUCTURES ON GARZA-LITTLE ELM RESERVOIR, TEXAS,
Geological Survey, Austin, Tex.
C. R. Gilbert, and S. P. Sauer.
Geological Survey Open-file Report, September 1969. 126 p, 38 fig, 21 tab, 41 ref.

Descriptors: *Flood control, *Check structures, *Reservoir yield, *Reservoirs, *Texas, Dams, Reservoir operation Water yield, Trap efficiency, Mathematical models, Computer programs, Hydrology, Water balance, Hydrologic budget, Reservoir evaporation, Reservoir silting, Hydrologic data, Data collections, Groundwater, Bank storage.
Identifiers: Garza-Little Elm Reservoir (Texas).

The effects of systems of floodwater-retarding structures on downstream water and sediment yield were studied in northern Texas. The project includes 11 study areas ranging from 18 to 80 sq mi in size and from 0 to 67% controlled by floodwater-retarding structures. Average annual runoff ranges from about 2 to 7 inches. This report presents results of analyses, development of methodology, and results of application of methods for defining the downstream effects of systems of floodwater-retarding structures. Trap efficiency of most floodwater-retarding structures was found to be about 97%. Average annual water consumption ranged from 1.57 inches of equivalent runoff in the most eastern study area, where annual runoff averaged 6.96 inches, to 0.77 inch of equivalent runoff in the most western study area, where the average annual runoff was 2.35 inches. A mathematical response model of the floodwater-retarding reservoir systems and the entire drainage basin yields monthly water and sediment inflow to the water-supply reservoir. Results of the firm-yield study indicated that with full development annual firm yield would have been initially reduced by 10%. After 30 or more years, when the permanent pools of the floodwater-retarding reservoirs would have been mostly filled with sediment, the firm yield was found to be almost the same with or without the upstream development. (Knapp-USGS)
W70-05637

SEVERAL DYNAMIC PROGRAMMING ALGORITHMS AND THEIR APPLICATION TO A DAM PROBLEM,
California Univ., Berkeley. Operations Research Center.
For primary bibliographic entry see Field 06A.
W70-05770

THERMAL POLLUTION: STATUS OF THE ART,
Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 05D.
W70-05778

THE EVAPORATION OF DROPS OF PURE LIQUIDS AT ELEVATED TEMPERATURES: RATES OF EVAPORATION AND WET-BULB TEMPERATURES,
Wisconsin Univ., Madison.
Carl G. Downing.
A.I.Ch.E. Journal, Vol. 12, No. 4, p760-766, July, 1966. 6 fig, 1 tab, 45 ref.

Descriptors: *Evaporation, *Heat transfer, Mass transfer, Evaporators, Temperature, Thermal properties, Condensers, Evaporation pans, Evaporation control, Air-water interfaces, Heating, Saturation, Vapor pressure, Water loss.

The rates of evaporation at the wet-bulb temperatures have been correlated for drops of pure liquids evaporating in streams of high-temperature air. The four liquids studied were acetone, benzene, n-hexane, and water. The drops were on the order of a millimeter in diameter and were suspended in a free jet of dry, vapor-free air that ranged in temperature from 27 deg C to 340 deg C. Reynolds numbers ranged from 24 to 325. Corrections to the Nusselt number to account for the heat lost to the outwardly-diffusing vapor ranged up to about 35%. Main conclusions are: (a) Drop vibration has no effect upon the rate of drop evaporation, and (b) film theory analysis gave a first-order approximation to the correlation correction at high rates of heat and mass transfer. (Upadhyaya-Vanderbilt)
W70-05793

8B. Hydraulics

BEACH CYCLES IN SOUTHERN CALIFORNIA,
Corps of Engineers, Washington, D.C. Beach Erosion Board.
Francis P. Shepard.
Available from the Clearinghouse as AD-699 397, $3.00 in paper copy, $0.65 in microfiche. Beach Erosion Bd, Technical Memorandum no 20. July, 1950. 31 p.

Descriptors: *Beaches, *Beach erosion, *Ocean waves, Structures, Particle size, Storms, Tides, Periodic variations, Oceanography.
Identifiers: Submarine canyons, Winter.

The large waves accompanying winter storms cause a widespread denudation of southern California beaches. During the summer period of small waves the sand is brought back, completing an annual cycle. The beach berms vary in width with the seasonal changes so that in general they are widest at the end of summer and narrowest at the end of winter. Variation in berm width is related also to the spring and neap tides, the berms being widest during neap tides and narrowest during spring tides. The cutting back of the berms often results in scarp formation at the top of the foreshore, the scarps being most commonly developed in the fall during the first period of large waves following the small waves of summer. In addition to offshore-onshore movements of sand there are also important lateral shifts. The sand is shifted along the beach in the direction in which the waves are approaching. As a result of this lateral shift the northwest storms of winter cause the southern ends of some beaches to grow during the winter, and the southerly approach during the summer moves the sand north and therefore produces a cut.
W70-05622

COMPLETENESS THEOREM FOR NON-SELFADJOINT EIGENVALUE PROBLEMS IN HYDRODYNAMIC STABILITY,
Rensselaer Polytechnic Inst., Troy, N.Y.
R. C. DiPrima, and G. J. Habetler.
Available from the Clearinghouse as AD-698 898, $3.00 in paper copy, $0.65 in microfiche. Archive for Rational Mechanics and Analysis, Vol 34, No. 3, p 218-227, 1969, 11 refs. Contract DA-31-124-ARO (D)-269.

Descriptors: *Hydrodynamics, Stability, Equations.
Identifiers: Eigenvalues, Orr-Somerfeld equation.

A number of problems in the linear theory of hydrodynamic stability lead to Eigenvalue problems of the form (L - lambda M)phi=0. Here L and M are ordinary differential operators or ordinary matrix differential operators, and phi is a scalar function or a vector function on a finite interval which satisfies appropriate homogeneous boundary conditions at the endpoints. Perhaps the best known example is the classical Orr-Sommerfeld equation, which arises in a study of the stability of plane parallel viscous flow to two dimensional disturbances. A Second class of problems occurs in a study of the stability of a layer of fluid heated from below (the Benard problem) or the stability of the viscous flow between rotating concentric cylinders (the Taylor problem). A general theorem is obtained which is an extension of NAIMARK's theorem and which is applicable to the Taylor stability problem as well as to the parallel flow stability problem and to various generalizations of these problems. The generalized Taylor stability problem and the Orr-Sommerfeld equation are considered.
W70-05632

TRACER AIDS INTERPRETATION OF PUMPING TEST,
Oak Ridge National Lab., Tenn.
For primary bibliographic entry see Field 05G.
W70-05678

A FINITE ELEMENT SOLUTION OF THE ONE-DIMENSIONAL DIFFUSION-CONVECTION EQUATION,
California Univ., Davis.
Gary L. Guymon.
Water Resources Research, Vol 6, No 1, p 204-210, February 1970. 7 p, 1 tab, 9 ref. NSF Grant GZ-790.

Descriptors: *Flow, *Open channel flow, *Groundwater movement, *Diffusion, *Convection, *Equations, Mathematical studies, Computers, Computer programs, Data processing.
Identifiers: Finite difference method.

The one-dimensional diffusion-convection equation has been widely used to describe approximately the transient motion of a subset of particles in river flow or porous media flow. An equivalent variational principle to the governing partial differential equations of motion is given, and a finite element solution is developed requiring only approximations in the space domain. The solution is applicable to a wide variety of field problems because it can account for a variety of boundary conditions. Additionally, the solution is not dependent upon constant parameters of motion over the entire domain of interest. (Knapp-USGS)
W70-05681

SECONDARY FLOWS IN CURVED OPEN CHANNELS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
Yoshio Muramoto.
Proceedings 12th Congress of International Association for Hydraulic Research, Sept 11-14, 1967, Colorado State Univ, Fort Collins, Vol 1 (River hydraulics), Paper A53, p 429-437, 1967. 9 p, 8 fig, 1 tab, 15 ref.

Descriptors: *Vortices, *Meanders, *Alluvial channels, Open channel flow, Mathematical studies, Boundary processes, Turbulence, Turbulent flow, Channel morphology, Steady flow, Water circulation, Model studies, Hydraulic models.
Identifiers: *Secondary flows.

The theoretical consideration of secondary flows is so complicated that most of previous studies are found to have been restricted to the analysis of the behavior of the flow in a fully developed region of the curved channel. The internal structure of curved flow is analyzed on the basis of the measurement of 3 velocity components and the calculation of vorticity components of the flow in a curved open channel. The flow in a curved section is divided into the following three regions in a mathematical model: a generating region; a developing region; and a fully developed region of the secondary flow. Several analytical results show the characteristics of the flow. (Knapp-USGS)
W70-05739

MODEL SIMILARITY AND TRAINING OF RIVER WITH LARGE CHANNEL IRREGULARITIES,
Hydraulic Research Inst., Prague (Czechoslovakia). Dept. of Technical Hydromechanics.
For primary bibliographic entry see Field 02E.
W70-05741

SOME RELATIONS OF ENERGY, ROUGHNESS, AND CHANNEL GEOMETRY IN THE LOWER MISSISSIPPI RIVER,
Corps of Engineers, Vicksburg, Miss.
For primary bibliographic entry see Field 02E.
W70-05742

AN APPROXIMATE THEORY OF SECONDARY FLOWS AT THE BEND OF THE RIVER COURSE,
American Inst. of Water Problems and Hydrotechnics, Yerevan (USSR).
For primary bibliographic entry see Field 02E.
W70-05744

SECONDARY CURRENTS IN CURVED STRATIFIED RIVERS,
Manchester Univ. (England). Inst. of Science and Technology.
For primary bibliographic entry see Field 02E.
W70-05745

SOME ASPECTS OF FLOW IN MEANDERING CHANNELS,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 02E.
W70-05747

THERMAL REGIME OF TURBULENT BOUNDARY LAYERS AT CONSTANT PHYSICAL PROPERTIES WITH BLOWING, (IN FRENCH),
Aerodynamics Research Centre, Poitiers (France).
L. F. Tsen, and C. Quemard.
Int. J. Heat Mass Transfer, Vol 11, p1127-1139, 1968. 10 fig, 3 tab, 20 ref.

Descriptors: *Heat transfer, *Mass transfer, *Turbulent boundary layers, Turbulent flow, Turbulence, *Air circulation, Air masses, Reynolds number, Eddies, Viscosity, Diffusion, Momentum transfer, Evaporation.
Identifiers: Theory of heat transfer.

The mean energy equation of the homogeneous, incompressible turbulent boundary layer with blowing is numerically integrated and the Spalding number computed with the following assumptions: constant laminar and turbulent Prandtl numbers; constant rate of flowing or suction, step wall temperature distribution; and a unified low of the wall. The numerical results are compared with some measurements of velocity and temperature profiles in the boundary layer. Computations were performed for Prandtl numbers, Pr = 0.7 (heat transfer in air) Pr = 0.8 (Vapor diffusion) and Pr = 1 (momentum). (Novotny-Vanderbilt)
W70-05779

ON THE TURBULENT HEAT TRANSFER BY FREE CONVECTION FROM A VERTICAL PLATE,
Tokyo Univ. (Japan). Faculty of Engineering.
Hiroharu Kato, Niichi Nishiwaki, and Masaru Hirata.
Int. J. Heat Mass Transfer, Vol 11, p1117-1125, 1968. 9 fig, 1 tab, 9 ref.

Descriptors: *Heat transfer, *Convection, *Turbulence, Turbulent flow, Temperature, Thermal properties, Heat pollution, Thermal pollution, Diffusion, Viscosity, Boundary layers, Heat flow, Heating, Cooling, Buoyancy.

Until now, the problem on the turbulent heat transfer by free convection has been solved by the profile method whose velocity and temperature profiles are given by experiments. In this paper, shear stress, heat flux, and eddy diffusivity distribution are assumed using the result of forced convection heat transfer, then the coupled partial differential equations for velocity and temperature, which are reduced to simpler forms, can be easily solved by the trial and error method. The result can be applied for a wider range of Grashof and Prandtl numbers than that obtained from usual equations. On transition from laminar to turbulent, a certain dimensionless criterion is proposed, which gives the ratio of energy of mean flow and that dispersed near the wall. The same dimensionless value can be applied for both forced and free convection. (Novotny-Vanderbilt)
W70-05781

INTERNAL HYDRAULICS OF THERMAL DISCHARGE DIFFUSERS,
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 05D.
W70-05788

EQUATIONS FOR THE MASS- OR HEAT-TRANSFER COEFFICIENT IN TURBULENT MOTION,
Institutul Politehnic Bucuresti (Rumania).
E. Ruckenstein.
Int. J. Heat Mass Transfer, Vol. 9, p441-451, 1966. 24 ref.

Descriptors: *Mass transfer, *Heat transfer, *Turbulence, Air-water interfaces, Surfaces, Reaeration, Boundaries, Turbulent flow, Open channel flow, Diffusion, Thin films.
Identifiers: Liquid films.

The renewal models used by several authors for representing the turbulent process in the vicinity of a boundary give only the dependence of the transfer coefficient on the diffusion coefficient or thermal diffusivity. In this paper, a number of ways are suggested by means of which this partial information supplied by renewal models may be completed with information of a hydrodynamic nature. The first one makes use of dimensional considerations similar to those used in the classical theory; the second way is based on the instability theory and the third one on certain assumptions concerning the form of the solutions of the equation of motion in the turbulent quasi-steady state. The first way is applied to the mass transfer in the vicinity of a solid boundary and also to the mass transfer in the vicinity of a fluid boundary. The other two ways are applied to the case of mass transfer in a liquid film moving along a vertical wall and to the case of heat transfer between a fluidized bed and a wall. A comparison between the physical model method and the classical one is also included. (Novotny-Vanderbilt)
W70-05789

THE PREDICTION OF THE TRANSPORT PROPERTIES OF A TURBULENT FLUID,
Glasgow Univ. (Scotland).
J. R. Tyldesley, and R. S. Silver.
Int. J. Heat Mass Transfer, Vol. 11, p 1325-1340, 1968. 10 fig, 1 tab, 19 ref.

Descriptors: *Mass transfer, *Heat transfer, *Turbulence, Velocity, Momentum equation, Reynolds number, Turbulent flow, Viscosity, Mixing, Temperature, Hydraulics, Eddies, Thermal pollution, Thermal conductivity, Thermal properties.

The transport properties of a turbulent fluid are investigated using a simple model to represent the detailed fluid behavior. In the model, this is attributed to the motions of fluid entities of varying size, shape and velocity, and an analysis is made to find the effect on the whole system, of interactions and transport between the individual entities. The analysis enables expressions to be found for the diffusivities of mass, momentum, and energy in terms of properties of the turbulence. Experimental values of the various diffusivity ratios compare favorably with the theoretical predictions. It is concluded that the model is a useful concept for predicting the bulk behavior in turbulent flow. (Novotny-Vanderbilt)
W70-05790

HEAT TRANSFER BIBLIOGRAPHY,
Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
E. R. G. Eckert, E. M. Sparrow, W. E. Ibele, and R. J. Goldstein.
Int. J. Heat Mass Transfer, Vol. 11, p583-603, 1968. 760 ref.

Descriptors: *Heat transfer, Mass transfer, Boundary layers, Conductivity, Evaporation, Cooling, Heating, Temperature, Thermal properties, Hydraulics, Air-water interfaces, Shear, Bibliographies, Reynolds number, Heat flow, Thermal radiation.
Identifiers: Heat transfer bibliography.

This bibliography contains 760 references on heat transfer problems. The literature review is divided into the following areas: (1) Applications of heat transfer (2) boundary layers problems, (3) change of phase and two-phase flow, (4) channel flow, (5) conduction, (6) heat and mass transfer, (7) liquid metals, (8) magnetohydrodynamics, (9) natural convection, (10) packed and fluidized beds, (11) radiation, (12) rotating surfaces or fluids, (13) thermodynamics and transport properties, (14) transfer mechanisms. (See also W70-05792). (Novotny-Vanderbilt)
W70-05791

HEAT TRANSFER BIBLIOGRAPHY,
Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
E. R. G. Eckert, E. M. Sparrow, W. E. Ibele, and R. J. Goldstein.
Int. J. Heat Mass Transfer, Vol. 11, p899-915, 1968. 585 ref.

Descriptors: *Heat transfer, Mass transfer, Temperature, Thermal properties, Turbulent flow, Boundary layers, Bibliographies, Convection, Conduction, Heating, Cooling, Channel flow, Heat budget, Heat balance, Enthalpy, Entropy, Latent heat, Thermal radiation, Evaporation, Thermal capacity, Water temperature, Melting, Heat pollution, Thermal pollution.
Identifiers: Thermal problems bibliography.

Comprehensive literature survey on heat transfer problems is presented. The bibliography contains 585 references on the following topics: (1) application of heat transfer theory, (b) boundary layers problems, (c) change of phase and two-phase flow, (d) channel flow, (e) conduction, (f) heat and mass transfer, (g) low density flow, (h) magnetohydrodynamics, (i) measurement techniques, (j) natural convection, (k) packed and fluidized beds, (l) radiation, (m) rotating surfaces or fluids, (n) thermodynamics and transport properties. (See also W70-05791). (Novotny-Vanderbilt)
W70-05792

FREE CONVECTION IN AN AIR-WATER VAPOR BOUNDARY LAYER,
Minnesota Univ., Minneapolis.
E. M. Sparrow, J. W. Yang, and C. J. Scott.
Int. J. Heat Mass Transfer, Vol. 9, p 53-61, 1966, 4 fig, 6 ref.

Descriptors: *Evaporation, Air-water interfaces, Diffusion, Heat balance, Heating, Latent heat, Heat transfer, Energy budget, Boundary processes, Boundary layers, Mass transfer, Evapotranspiration, Saturation, Radiation, Viscosity.

This paper describes an experimental investigation, supported by analysis, of free convection in an air-water vapor boundary layer at the stagnation point of a horizontal cylinder. A two-component boundary layer is created by the effusion of water vapor from the porous surface of the cylinder; the ambient gas is pure air. The results of both experiment and analysis indicate that the heat transfer decreases as the surface mass-transfer rate increases. At moderate blowing rates, there is a good agreement between the experimentally and analytically determined Nusselt numbers. At higher mass-transfer rates, the data lie above the analytical predictions by about 25 per cent. This departure is attributed to a fluctuating motion in the boundary layer. (Novotny-Vanderbilt)
W70-05794

BED TOPOGRAPHY EFFECT ON FLOW IN A MEANDER,
Iowa Univ., Iowa City. Inst. of Hydraulic Research.
Chin-lien Yen.
ASCE Proceedings, Journal Hydraulics Division, Vol 96, No HY1, Paper 7003, p 57-73, January 1970. 17 p, 6 fig, 1 tab, 11 ref, append. OWRR Project A-029-IA.

Descriptors: *Channel morphology, *Meanders, *Alluvial channels, *Hydraulic models, Open channel flow, Hydraulics, Streamflow, Sediment transport, Regime, Hydraulic similitude, Model studies, Topography.
Identifiers: Streambed topography.

Stabilized bed topography in a meandering channel with fixed walls and movable bed was measured at various width-depth ratios and Froude numbers. Velocity and bed-shear distributions were measured in a fixed-bed model whose configuration conformed to the stabilized topography of the movable-bed model. An approximate theoretical analysis of the bed configuration under fully developed flow conditions shows that the transverse bed slope is directly proportional to a parameter characterizing the relative importance of fluid inertia compared with the gravity acting on a particle. Good agreement has been observed between the theoretical and experimental results in the downstream half of the model channel. The effects of formation of the bed topography on the flow characteristics are considered. (Knapp-USGS)
W70-05887

RISKS IN HYDROLOGIC DESIGN OF ENGINEERING PROJECTS,
Illinois Univ., Urbana. Dept. of Civil Engineering.
Ben Chie Yen.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY4, Paper 7229, p 959-966, April 1970. 8 p, 3 fig, 1 tab, 5 ref. OWRR Proj No B-043-ILL.

Descriptors: *Flood control, *Reservoir design, *Risks, *Design criteria, *Probability, Hydrology, Decision making, Stochastic processes, Rainfall-runoff relationships, Synthetic hydrology, Flood forecasting, Hydraulic design, Mathematical studies.
Identifiers: Hydrologic design criteria.

By using the probability theory it has been shown that for any hydrologic design with a certain return period and expected life of a project there is always a calculated risk of failure involved. For a time invariant hydrologic system this simple risk can be computed. Conversely, if the expected project life and the simple risk are known, the corresponding

design return period can be determined. Such a determination of the return period is independent of the type of distribution and the plotting position of the hydrologic data. Furthermore, there are additional risks and uncertainties involved which should be considered in hydrologic design of engineering projects such as those due to limited record of data available, using rainfall records to synthesize runoff information, stochastic nature of the hydrologic system, and the techniques utilized in the mathematical processing of the data. (Knapp-USGS)
W70-05905

BOUNDARY SHEAR DISTRIBUTION IN OPEN CHANNEL FLOW,
Indian Inst. of Tech., Kharagpur. Dept. of Civil Engineering.
S. N. Ghosh, and N. Roy.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY4, Paper 7241, p 967-994, April 1970. 28 p, 22 fig, 3 tab, 18 ref, append.

Descriptors: *Open channel flow, *Boundary layers, Roughness (Hydraulic), Boundary processes, Current meters, Shear drag, Instrumentation, Model studies, Hydraulic models.
Identifiers: Boundary layer flow, Secondary flow, Boundary shear.

Boundary shear distribution in both rough and smooth open channels of rectangular and trapezoidal sections is obtained by direct measurement of shear drag on an isolated length of the test channel utilizing the technique of a three point suspension system suggested by Bagnold. Existing shear measurement techniques have been reviewed critically. Comparison of the measured distribution has been made with other indirect estimates, from isovels, and Preston tube measurements, based on Keulegan's resistance laws. The discrepancies between the direct and indirect estimates are explained. Of the two indirect estimates the surface pitot tube technique is found to be more reliable. The influence of secondary flow on the boundary shear distribution could not be accurately defined in the absence of a dependable theory on secondary flow. (Knapp-USGS)
W70-05907

8C. Hydraulic Machinery

ROTATING-BOOM PLOT IRRIGATOR WITH OFFSET MOUNTING,
Agricultural Research Service, Fort Collins, Colo. Northern Plains Branch; and North Dakota State Univ., Fargo. Agricultural Experiment Station.
For primary bibliographic entry see Field 03F.
W70-05610

8D. Soil Mechanics

SPRINKLER INTENSITY AND SOIL TILTH,
Utah State Univ., Logan. Agricultural and Irrigation Engineering Dept.; and Utah Agricultural Experiment Station, Logan.
For primary bibliographic entry see Field 02G.
W70-05611

CONSTRUCTION OF A ROCK-FILL DAM BY LARGE-SCALE DIRECTIONAL DOWNTHROW BLASTS,
California Univ., Berkeley. Lawrence Radiation Lab.
R. V. Sedykh.
UCRL-Trans-10402, October, 1969, 25 p. Available from the Clearinghouse as PB-188 149T, $3.00 in paper copy, $0.65 in microfiche. Energeticheskoe Stroiteslstvo (USSR) n 85 p 35-41, Jul 68.

Descriptors: *Rockfill dams, Craters, Construction, *Excavation, Drainage, Rivers, Safety, Mudflows.
Identifiers: Downthrow blasts, Medeo (USSR).

Large-scale cratering and downthrow blasts find wide application in the construction of hydraulic engineering works. The use of blast energy for the formation of the main body of a rock-fill dam is of great interest. A typical example of such operations, which has recently been completed, is the construction of a mudflow protection dam in the locality of Medeo near the town of Alma-Ata.
W70-05624

UTILIZATION OF MARGINAL LANDS FOR URBAN DEVELOPMENT,
Partner, Mueser, Rutledge, Wentworth and Johnston, New York.
Philip C. Rutledge.
ASCE Proceedings, Journal Soil Mechanics and Foundations Division, Vol 96, No SM1, Paper 7000, p 1-22, January 1970. 22 p, 14 fig, 9 ref.

Descriptors: *Land development, *Urbanization, *Landfills, *Wetlands, Economics, Land use, Drainage, Land reclamation, Soil stabilization, Soil engineering, Soil mechanics, Costs, Planning, City planning.
Identifiers: *Marginal wetlands, Urban expansion.

The problems and costs of creating useful land from marginal wet lands around cities are becoming increasingly important to planners and engineers. Such lands are below water or occasionally flooded, are underlaid by soft and highly compressible organic alluvium, and frequently are covered by garbage and solid refuse. Making usable land requires fill to raise the grade above flooding. The major problem is excessive settlements under the load of this fill. Precompression by surcharge loading, possibly with sand drains, is required to minimize future settlements and make land acceptable for light buildings, streets, and municipal services. Heavier buildings require pile foundations extending through all compressible soils and pile supported waterfront structures may be required. The 1967 costs for land development range from $30,000 to $150,000 per acre and additional costs of foundations for nine-story buildings range from $9.00 to $17.00 per sq ft. Waterfront developments with deep water perimeters may cost upward of $300,000 per acre. Data are provided for estimating design requirements and site development costs on a comparable basis. (Knapp-USGS)
W70-05881

8H. Rapid Excavation

CONSTRUCTION OF A ROCK-FILL DAM BY LARGE-SCALE DIRECTIONAL DOWNTHROW BLASTS,
California Univ., Berkeley. Lawrence Radiation Lab.
For primary bibliographic entry see Field 08D.
W70-05624

8I. Fisheries Engineering

FISH AND GAME--PRESERVES AND RESTORATION PROJECTS (GAME FISH MANAGEMENT AND PROTECTION).
For primary bibliographic entry see Field 06E.
W70-05772

09. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

AQUATIC SCIENCES IN THE GREAT LAKES AREA.
For primary bibliographic entry see Field 09D.
W70-05738

9D. Grants, Contracts, and Research Act Allotments

AQUATIC SCIENCES IN THE GREAT LAKES AREA.

Interagency Committee on Oceanography Report No 4, Vol 2, 1967. 50 p, 3 index.

Descriptors: *Great Lakes region, *Hydrology, *Projects, *Research facilities, Grants, Programs, Research and development, Water resources, Lakes, Oceanography, Governments, Limnology, Hydrogeology, Biology, Great Lakes.
Identifiers: Great Lakes research, Water resources research.

Research projects in the Great Lakes at university and institutional laboratories, as well as of those conducted by agencies of the Canadian or United States Governments or by Provincial and State agencies are summarized and listed. For each project the title of project, principal investigator, sponsor, funding, if known, and purpose and nature of project are listed. In addition to the listing of projects under sponsoring agencies, several additional indices have been included for cross-referencing: principal investigators are listed alphabetically; projects are listed by function or subject; projects are listed by specific geographic location. (Knapp-USGS)
W70-05738

10. SCIENTIFIC AND TECHNICAL INFORMATION

THE ARCHIVES FOR GROUNDWATER LEVELS T.N.O. IN THE NETHERLANDS,
Rijksinstituut voor Drinkwatervoorziening, The Hague (Netherlands).
For primary bibliographic entry see Field 07C.
W70-05735

HEAT TRANSFER BIBLIOGRAPHY,
Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 08B.
W70-05791

HEAT TRANSFER BIBLIOGRAPHY,
Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 08B.
W70-05792

A NATIONAL WATER DATA SYSTEM FOR CHILE,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07C.
W70-05892

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